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NATIONAL DAM INSPECTION PROGRAM. BIG BOULDER DAM (NDS ID NUMBER--ETC(U)
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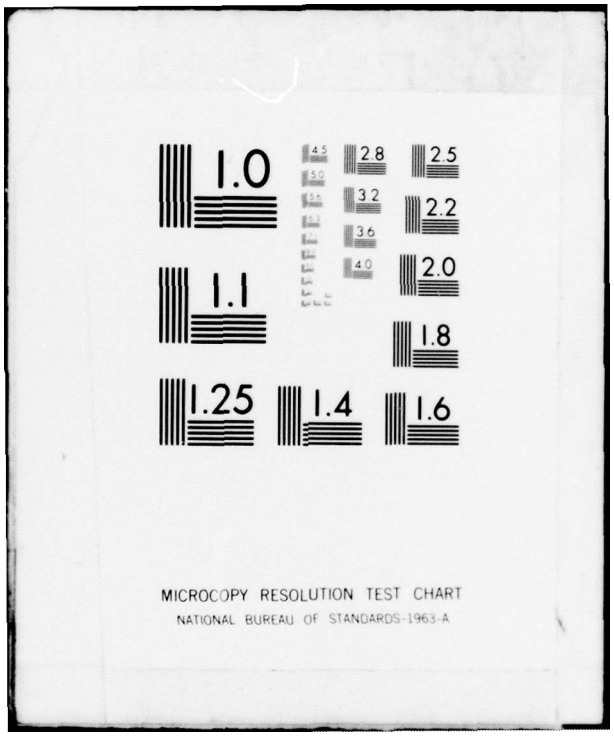
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DELAWARE RIVER BASIN
GRASS LAKE CREEK, CARBON COUNTY
PENNSYLVANIA
NDS ID PA. 00615
DER ID 13-93

LEVEL II

BIG BOULDER DAM

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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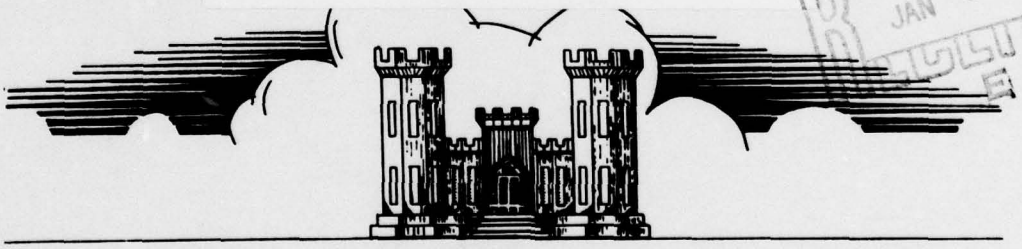

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(6) National Dam Inspection Program.
Big Boulder Dam (NDS ~~ID~~ PA 00615,
DER ~~ID~~ 13-93),

(1)

DELAWARE RIVER BASIN,

BIG BOULDER DAM
CARBON COUNTY, PENNSYLVANIA. Phase I
Inspection Report,

NDS I.D. NO. PA 00615
DER I.D. NO. 13-93

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM.

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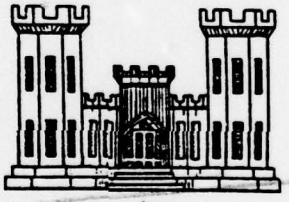

(10) John/Boschuk, Jr

Prepared by:

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Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

JULY 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is to expeditiously identify those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	Big Boulder Dam
County Located:	Carbon County
State Located:	Pennsylvania
Stream:	Grass Lake Creek
Coordinates:	Latitude 41° 2.7'
	Longitude 75° 35.0'
Date of Inspection:	11 May 1979

Big Boulder Dam is owned by the Big Boulder Corporation and serves as a recreation lake and water supply for snow making at the lodge. The dam was built in the summer of 1957, and is classified as an "Intermediate" size dam by virtue of its 1,971 acre-foot maximum storage capacity. Big Boulder Lake is formed by Dam A across Grass Lake Creek and Dam B, a saddle dam on the watershed divide. In the event that Dam B fails, extreme property damage and a possibility for the loss of life exists downstream along Swamp Run, thus classifying the structure as a "High" hazard dam.

The hydrologic and hydraulic calculations presented in Appendix C and discussed in Section 5 indicate that the spillway system for this structure is rated as "Adequate" as it will pass the PMF.

On the basis of the visual inspection on 11 May 1979, and review of available construction and design documentation, the dam and appurtenances of Big Boulder Reservoir appear to be functioning satisfactorily with the exception of undesirable seepage at the downstream toe of Dam A. It is understood that the Owner's engineer is aware of this condition and is currently making plans to correct the situation. The condition of the foundations for Dams A and B could not be assessed. The resident engineer's reports leave some question as to the quality of foundation preparation. Except for the seepage, there were no other anomalous features noted during the field inspection of unusual foundation movements or conditions indicative of foundation problems. Detailed discussions are presented in Sections 1, 6 and 7 of the report.

Based on the findings presented in this report, the following recommendations are presented. These recommendations should be performed under the direction of a registered professional engineer experienced in the design of dams.

1. Seepage at the downstream toe of Embankment A should be assessed and controlled as soon as possible.

2. Seepage at the right side of the spillway at Dam A should be monitored for increases in seepage rates or the presence of turbidity. In the event either condition occurs, the condition should be reviewed immediately and appropriate action taken, if necessary.

3. Seepage noted along the downstream toe of Dam B should be monitored periodically for turbidity or increases in flow. In the event a change occurs, conditions should be reviewed and appropriate remedial measures taken.

Operation and maintenance procedures should be established as soon as possible. This procedure should include a checklist to insure that all items are carefully inspected and maintained in the best possible condition.

John Boschuk, Jr., P.E.
Pennsylvania Registration 27450E
Woodward-Clyde Consultants

Date 7/30/79

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL ENGINEER
JOHN BOSCHUK, JR.
No. 27450-E

John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants

Date 7/30/79

STATE OF MARYLAND
John Henry Frederick, Jr.
No. 7301
REGISTERED PROFESSIONAL ENGINEER

APPROVED BY:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date 11 Sep 79

OVERVIEW
BIG BOULDER DAM, CARBON COUNTY, PENNSYLVANIA

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
BIG BOULDER DAM
NATIONAL ID #PA 00615
DER #13-93

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Big Boulder Lake is formed by two earth dams, Dam A and Dam B. Dam A, located across Grass Lake Creek, is approximately 21.5 feet high and 759 feet long. It contains an upstream impervious fill over a core trench excavated on 1H:1V slopes and a 10 foot base width. The downstream half of the section is random fill and a rock toe with a 12 inch filter blanket extending from the toe to the cutoff trench. The upstream slope has a five foot wide bench at elevation 1,772. Above elevation 1,772, the slope is 3H:1V. Below elevation 1,772, the slope is 4H:1V. From crest to berm, the embankment is protected with 18 inches of riprap on a six inch filter bed. The crest of the dam is 15 feet wide. The downstream slope is 3H:1V.

Dam A has a concrete ogee weir spillway with a crest elevation at 1,775.0. A four foot wide foot bridge supported by one pier crosses the weir. The stilling basin is approximately 65 feet long with a base at elevation 1,754. Dam A has an intake tower located on the left side of the spillway. The reservoir can be drained through a 24-inch pipe located at elevation 1,760 within the intake tower. The sluice gate is controlled by a hand wheel located on top of the tower. In addition, the intake tower is fitted with a four-inch pipe at elevation 1,768, also controlled from the top of the tower, and is partially open to maintain minimum flow requirements. Both intakes discharge through the

spillway wall. Plan and section views are included as Plates 2 through 6, Appendix E.

Dam B, an earth dike across a saddle, is 18.5 feet high and approximately 415 feet long. Dam B has an impervious upstream section and a downstream random fill zone with a rock toe below 1,770. The dam is underlain by a 12 inch filter blanket over the rock foundation. An upstream impervious blanket extends 250 feet into the reservoir. Where the dam is not founded on rock, an impervious core trench is included. The upstream slope is 1.5H:1V above elevation 1,778 and 2.5H:1V below, entirely covered with 18 inches of riprap on a six inch filter blanket. The dam crest is 30 feet wide with an 18 foot wide paved access road. The downstream slope is the same as the upstream slope without riprap. After construction, downstream leakage became excessive and the dam foundation was grouted as described in Subsection g.

b. Location. Dam A is located across Grass Lake Creek in Kidder Township, Carbon County, Pennsylvania. The dam is near Route 903, approximately 1.9 miles west-southwest of the intersection of Routes 903 and 115. Dam B is at the watershed divide between Grass Lake Creek and Swamp Run. The dam site and reservoir are shown on USGS Quadrangle entitled "Blakeslee, Pennsylvania" at coordinates N 41° 2.7' W 75° 35'. A regional location plan of Big Boulder Dam and reservoir is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as an "Intermediate" size dam by virtue of its 1,971 acre-foot maximum storage capacity.

d. Hazard Classification. A "High" hazard classification has been assigned to this structure. In the event Dam B fails, extensive property damage and possible loss of life would occur downstream along Swamp Run.

e. Ownership. Big Boulder dam is owned and maintained by Big Boulder Corporation. All correspondence should be addressed to Mr. Curtis Kemmerer, Property Division Manager, Blue Ridge Realty Company, Big Boulder Corporation, Blakeslee, Pennsylvania 18610.

f. Purpose of Dam. The purpose of this dam is for recreation and water supply for man-made snow at the ski resort.

g. Design and Construction History. Justin & Courtney* of Philadelphia, Pennsylvania, was retained by the Lake

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* Justin & Courtney is now a division of O'Brien & Gere, Inc., of Syracuse, New York.

Harmony Development Company to perform a geotechnical investigation and design the two dams which create Big Boulder Lake. A preliminary report was submitted to the client noting the presence of soft clay under Dam A. The engineer evaluated the condition and proposed to allow the clay to remain in place and consolidate under the weight of the dam. The design was completed by March 1957 and application was made for a dam permit. The "Report Upon the Application of Lake Harmony Development Corporation" was prepared May 3, 1957. Specifications prepared by Justin & Courtney covered foundation preparation, embankment fill materials, compaction requirements, filter and riprap materials, concrete and steel. Mr. John J. Williams of Justin & Courtney was the resident engineer. Construction began in early 1957 and was completed by fall 1957. Bimonthly progress reports were sent to the State.

The files of Justin & Courtney were reviewed and the resident engineer's reports indicated that impervious materials were very difficult to find for construction of the dams. Resident engineer reports also indicated that during excavation of the foundation, the soft clays were uncovered but not removed. The engineer, with the State's approval, allowed the clays to crust over through dessication so that fill could be placed over them. In at least one instance, as a result of filling over a crust, severe pumping was noted during the fill process. In addition, during foundation preparation of Dam A, boils were found on the downstream side of the dam where peat and soft clay had been removed and backfilled with granular material. Apparently there were attempts to drain these boils in some manner and then to fill over the area.

At Dam B, foundation excavation revealed a highly boulderiferous area which required substantial quantities of undercutting to obtain suitable foundation materials.

At completion of the dam, water began to be impounded on or about October 18, 1957. In December 1957, Mr. N. C. Courtney certified in writing that all work associated with construction of Big Boulder Dam was performed in accordance with approved maps, plans, profiles and specifications.

About June 1, 1958, it was noted that the reservoir level was dropping faster than expected. Justin & Courtney investigated and a July 10, 1958 memorandum tentatively concluded that, while there was no seepage through Dam A, at least some seepage may be going through and around the left abutment and into the downstream swamp. Considerable seepage was passing through or around Dam B, as water was noticed

running in the rocks, occasionally cloudy or muddy immediately below the dam.

The upstream clay blanket (Dam B) was repaired at least once in an attempt to eliminate or reduce seepage through the dam. A "Summary of Construction Work of Blanket Improvement at Big Boulder Lake", November 8, 1961, indicates extensive rehabilitation work. A cutoff trench, 6 to 12 feet deep and 3 feet thick, was placed at the north end of the blanket extending from shoreline to shoreline. Water entered the west end of the trench at a rate of 300 gpm. After the 3 foot thick trench was backfilled with clay, a 15 foot wide, 10 foot deep and 80 foot long cutoff trench was installed. At the same time, riprap was removed from the dam face, exposing the impervious fill. A "hole" was located and repaired. Additional impervious fill was placed and the riprap replaced. In 1968, a grout program for Dam B was proposed by Justin & Courtney and performed by Sprague & Henwood of Scranton, Pennsylvania. Grout holes were drilled 10 feet on center and split spaced down to at least 2½ feet on center. Hole depths varied but the criteria was to extend the holes about 10 feet into solid rock. The stage grouting was to be performed from the top of the hole downward using a primary/secondary/tertiary system of drilling and grouting. Based on reports by Justin & Courtney's representatives, the grouting work effectively reduced the amount of seepage below Dam B by about 90 percent and is considered tolerable for Dam B.

In addition, two piezometers were installed, one on the upstream and one on the downstream crest, to monitor phreatic surface through the embankment. Since installation of the grout curtain and piezometers, Justin & Courtney has performed at least annual inspections of the site to monitor conditions. The most recent inspection of the site was performed on September 14, 1978, after which they submitted their annual inspection report to Big Boulder Corporation.

In 1963, an application was filed to install six inch high splashboards across the spillway to minimize water losses due to wave action. On April 29, 1963, the State of Pennsylvania prepared the "Report Upon the Application of Split Rock Lodge, Inc." and approved the installation of the splashboards, which did not raise the normal reservoir level. It is understood that these splashboards are no longer used.

h. Normal Operating Procedures. Normal reservoir level is controlled by the concrete ogee spillway which discharges into Grass Lake Creek. The 0.18 cfs minimum flow is released through a four-inch pipe in the control tower. The reservoir may be drained through a 24-inch pipe, which

discharges through the spillway wall below the weir. The sluice gate hoist is located on top of the control tower.

1.3 Pertinent Data.

A summary of pertinent data for Big Boulder Dam is presented as follows.

a.	Drainage Area (sq miles)	1.65
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood (Tropical Storm Agnes, 1972)	60
	Maximum Design Flood	2,525
	Top of Dam (embankment low point)	2,848
	Minimum Required Flow	0.18
c.	Elevation (feet above MSL)	
	Top of Dam	
	Dam A	
	Design	1,781.0
	Minimum	1,780.4
	Dam B (approximate)	1,782.0±
	Upstream Bench (Dam A)	1,772.0
	Spillway Crest	1,775.0
	Pond Drain Intake Invert	1,760.0
	Minimum Flow Release	1,768.0
	Top of Control Tower	1,781.0
	Base of Control Tower	1,754.0
	Spillway Basin Floor	1,754.0
d.	Reservoir (miles)	
	Length at Normal Pool	0.9
	Fetch at Normal Pool	0.9
e.	Storage (acre-feet)	
	Normal Pool	920
	Top of Dam (1,780.4)	1,971
f.	Reservoir Surface Area (acres)	
	Normal Pool	170±
g.	Dam Data	
	Type	Zoned rolled earth
	Length	
	Dam A	759 feet
	Dam B	415 feet

Height	
Dam A	21.5 feet
Dam B	18.5 feet
Crest Width	
Dam A	15 feet
Dam B	30 feet
Volume of Fill	To be determined
Side Slopes (Dam A)	
Upstream	
Below Elevation 1,772	4H:1V
Above Elevation 1,772	3H:1V
Downstream	3H:1V
Side Slopes (Dam B)	
Upstream	
Above 1,778	1.5H:1V
Below 1,778	2.5H:1V
Downstream	
Above Elevation 1,778	1.5H:1V
Below Elevation 1,778	2.5H:1V
Freeboard at Normal Pool (design)	6 feet
Cutoff	Core trench upstream of centerline, Dams A & B
Grout Curtain	Dam B only, single line

h. Discharge

Spillway	
Type	Concrete ogee weir
Length	56' including 14" pier
Discharge Basin	Concrete
Intake Tower	
Type	Concrete tower w/foot bridge to crest
Pond Drain	24" pipe and gate
Minimum Flow	4" pipe and valve

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of engineering data for Big Boulder Dam is presented in the checklist attached as Appendix A. Principal documents containing pertinent data used for this report include the "Report Upon the Application of Lake Harmony Development Company" dated May 3, 1957, the "Report Upon the Application of Split Rock Lodge, Incorporated" dated April 29, 1963, along with specifications, design drawings, miscellaneous correspondence, several progress reports and 13 construction photos in Department of Environmental Resources' (DER) files. Other information pertaining to the design and construction of this dam was obtained either from the Owner's representative or from discussions with the engineering staff of Justin & Courtney and review of their files.

The available data was sufficient to evaluate principal features of the dam and appurtenant structures in accordance with Phase I inspection criteria. Selected portions of the drawings are included in Appendix E of this report.

b. Design Features. Principal design features are illustrated on the plan, profile and cross-section plates of the embankments and appurtenant structures that are enclosed in Appendix E. These plates are reproduced from design drawings prepared by the engineer. A description of the design features is presented in Section 1.2 entitled "Description of Project".

2.2 Construction.

A description of the construction history, including remedial grouting of Dam B, is presented in Section 1.2, paragraph g.

2.3 Operational Data.

There are no operational records maintained. The minimum flow requirement of 0.18 cfs is maintained by the four-inch valve in the control tower. It is understood that monthly reservoir records are maintained by the Owner and that some type of rainfall reading and piezometer level records are also maintained by the Owner and sent to their engineer.

2.4 Evaluation.

a. Availability. All engineering data reproduced in this report and described herein and studied for this investigation were provided by the DER or the engineer and supplemented by discussions with the Owner and the engineer.

b. Adequacy. Data available for review from DER files, the Owner and information obtained from the engineer were considered sufficiently adequate to evaluate the overall features of the dam and appurtenant structures. It is noted that the embankment stability analysis for this dam was not available for review, but a summary of the spillway stability was available and is included as Plate 9, Appendix E.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. Observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix B, and are summarized and evaluated as follows. In general, the overall appearance of the dam and its appurtenant structures is good and seems to be well maintained. The Owner's staff periodically exercises both valves in the tower and keeps the spillway area clean of debris. Seepage, discussed in the following paragraph, is being monitored by the engineer and corrective action will be taken in the near future.

b. Dam. During the visual inspection, there were no indications of distortion in alignment or grade that would be indicative of movement of the embankment or foundations of either Dam A or B. Inspection of the downstream slope and adjacent downstream area of Dam A disclosed two zones of seepage. The first zone is located adjacent to the right wall of the spillway where seepage, discolored with iron staining, was noted. A photograph of this seepage is enclosed as Photograph 13. As the downstream rock toe does not contain a perforated collector pipe, this type of seepage would be expected. A second form of seepage was noted to the left of the spillway, as shown in Appendix B, sheet 5a, and documented by Photographs 10 and 11 in Appendix D. This seepage was flowing at a rate substantially greater than the seepage at the right spillway wall. It is noted that the Owner has retained Justin & Courtney to evaluate the seepage and recommend a method of control.

There are no signs of riprap distortion, movement or deterioration. The quality of rock used for riprap was assessed to be good.

The downstream area of Dam B was also inspected and some small wet areas were noted, as shown on sheet 5a, Appendix B. However, based on discussions with the Owner's engineer, seepage rates are at least 90 percent less than rates prior to grouting. The engineer concluded this seepage is controlled sufficiently to insure stability of the embankment.

There are no indications of surface cracks noted on the embankment crest or slopes of Dams A and B. The asphalt roadway across Dam B is in good condition. As shown on Photograph 8, Embankment A has settled approximately four to six inches below the spillway anti-seepage walls. As shown on

Plate 5, Section BB, the anti-seepage wing wall and the dam have the same design elevation.

c. Appurtenant Structures.

Appurtenant structures of this dam include the spillway and intake tower. The spillway was found to be in very good condition. At the time of the inspection, the splashboards were not in place.

The control tower was inspected and both the minimum flow release valve and the pond drain sluice gate were exercised and functioned properly. With the exception of some minor rust on the steel work of the bridge and intake tower, the tower appears to be in very good condition.

d. Reservoir. Reconnaissance of the reservoir disclosed no evidence of significant siltation, slope instability or other features that would significantly affect the flood storage capacity of the reservoir. The reservoir side slopes are stable with moderate to steep slopes and well vegetated, predominantly with trees.

e. Downstream Channel. The downstream channel below Dam A, which contains a spillway, is Grass Lake Creek. The downstream channel of Dam A is about five feet wide and the bed and banks of the channel are rocky. The banks are about four feet high and the flood plain is completely wooded. The valley gradient of this channel is approximately 0.02. About 1.1 miles below the dam, Grass Lake Creek enters Tunkhannock Creek. About 1.9 miles farther downstream along Tunkhannock Creek is a house built adjacent to the creek and subject to damage. About 0.5 miles farther downstream, the creek enters Tobyhanna Creek.

Below Dam B are headwaters of Swamp Run. Approximately 2.3 miles below Dam B, Swamp Run enters Mud Run. Approximately 0.5 miles farther downstream, there are at least 10 houses built in the flood plain subject to damage in the event of failure. The number and locations of these houses are sufficient to justify a high hazard classification.

3.2 Evaluation.

Inspection of the dam disclosed no evidence of apparent past or present movement that would indicate existing instability of the dams or attendant facilities. Seepage noted at the downstream toe is considered undesirable. However, it is understood that the Owner's engineers are evaluating this condition and are in the process of designing a method to control the seepage.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operational procedures are discussed in Section 1.2. Operation of the dam does not require a dam tender. Under normal conditions, all flow is discharged over the spillway at elevation 1,775. There are no formal written operation or maintenance procedures for this structure. However, a formal warning procedure has been established and a copy was given to the inspection team for review.

4.2 Maintenance of the Dam.

The dam is maintained by Big Boulder Corporation of Blakeslee, Pennsylvania. The maintenance staff periodically mow the grass, remove weeds and other vegetation from the slopes and perform minor cosmetic repairs to the embankment crest and slopes.

4.3 Maintenance of Operating Facilities.

The spillway, pond drain and intake tower are also maintained by the staff of Big Boulder Corporation. They clean debris from the spillway and maintain the valves and control tower in good condition.

4.4 Warning Systems In Effect.

The Owner, through its engineer, has written an adequate warning procedure which establishes a method for monitoring flows and warning downstream residents so they can evacuate the area, if necessary.

4.5 Evaluation.

It is judged that current operating procedures, which do not require a dam tender, are a realistic means of operating the relatively simple control facilities of Big Boulder Dam. However, these procedures should be formalized and issued to the appropriate staff to insure that this work continues in the satisfactory fashion that it has in the past. This inspection/operating procedure should include a maintenance inspection checklist which will be used during periodic inspections and maintenance to insure that the dam and its appurtenant facilities are maintained in the best possible condition.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. Three sheets of Justin & Courtney's calculations were available in State files. Statements as to spillway capacity and adequacy, as determined by the State, were in State files. The Owner supplied a copy of a September 1978 inspection report, which included a hydrology/hydraulic evaluation, by Justin & Courtney. Further calculations made as a part of this 1979 investigation are included in Appendix C.

The small mountaintop watershed is about two miles long and about 0.85 mile wide, having a total area of 1.65 square miles. Elevations range from 2,180 on the mountain to the south to 1,775 at normal pool level. The watershed is about 95 percent wooded with limited development. There is a small swamp at the upper end of the watershed and the reservoir is about 18 percent of the total watershed. The runoff characteristics are not expected to change significantly in the near future.

The original design estimated the peak inflow value to be 3,000 cfs resulting from a 24 inch rainfall. The 1978 evaluation by Justin & Courtney estimated the peak inflow value to be 8,500 cfs resulting from 20 inches of rain over the watershed. Further details of design/evaluation are listed in Appendix C.

In accordance with the criteria established by Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard potential classification is the Probable Maximum Flood (PMF).

b. Experience Data. Big Boulder Lodge maintains reservoir level records which are supplied to their engineer, Justin & Courtney. Rainfall records have been maintained periodically. The maximum reservoir level was about 5.5 inches over the spillway crest during Tropical Storm Agnes, 1972.

c. Visual Observations. On the date of the inspection, the only condition observed that would indicate a reduced spillway capacity (without overtopping the embankment) during an extreme event is settlement of up to seven inches adjacent to the spillway wall. Observations regarding the condition of the downstream channel, spillway and reservoir are located in Appendix B and discussed in Section 3.

d. Overtopping Potential. The overtopping potential of this dam was estimated using the "HEC-1, Dam Safety Version", computer program as all of the supporting calculations for Justin & Courtney's 1978 evaluation were not available. A brief description of the program is included in Appendix C.

Big Boulder Lake is connected by a culvert to Round Pond. Based on the Owner's five foot interval contour map, when Big Boulder Dam overtops, Round Pond will flow over natural ground both to the north and east. For purposes of this investigation, any potential flood water storage has been neglected and the assumption made that the dam rather than Round Pond will overtop during an extreme event.

Calculations for this investigation estimate spillway discharge of about 2,525 cfs without splashboards with the reservoir at the underside of the bridge. The HEC-1 program computed the peak PMF inflow to be 4,072 cfs. As shown in Appendix C, the maximum reservoir water surface elevation during the PMF is estimated to be 1,779.78 and, with the splashboards in place, 1,780.79.

e. Spillway Adequacy. As the spillway without splashboards will discharge the PMF without overtopping the embankment low point, the spillway is rated as "Adequate". If the splashboards are in place, the low point will be overtopped by five inches and the spillway rating would be "Inadequate". Therefore, as recommended by Justin & Courtney in their 1978 report, the splashboards should not be used.

f. Downstream Conditions. Downstream conditions have been discussed in detail in Section 3. In summary, there would be significantly more damage resulting from failure during passing of the PMF than high flows without failure during the PMF.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. Visual observations detected no evidence of existing embankment stability problems. Upstream riprap on both dams was stable and in good condition. Similarly, the riprap and vegetated downstream slopes of both dams was also considered in good condition. The asphalt surface across the crest of Dam B was assessed to be in good condition as well as the spillway and attendant facilities located at Dam A. Seepage at the downstream toe of Dam B was judged by the Owner's engineer to be stable and present no danger to the dam. Seepage on the downstream side of Dam A, noted by this inspection team and the Owner, has been assessed by their engineer to be in need of evaluation and control.

b. Design and Construction Data.

Design and construction documentation is described in Section 1.2. A summary of the spillway stability analysis is presented in Appendix E as Plate 9. Analysis of the embankment sections could not be located. Therefore, the embankment stability evaluation was based on an assessment of the geometric configurations and documentation in Department of Environmental Resources' files and the Owner's engineer's files which indicate that all work was performed in accordance with the engineer's approval. Based on these facts, it is assumed that the dam meets the engineer's requirements for stability.

c. Operating Procedures. There are no operational procedures for this structure. However, warning procedures do exist and are currently on file with the Owner.

d. Post-Construction Changes. Other than installation of the grout curtain at Dam B to control seepage, there are no significant changes made to this structure. It is understood that recommendations to control undesirable seepage from the toe of Dam A are forthcoming from the Owner's engineer.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static conditions, it can be assumed safe for any expected earthquake conditions. Since the factors of safety for the static stability of this embankment could not be obtained from the engineer, an assessment of the seismic stability of the dam could not be made.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection and review of the construction and limited design documentation indicates that the dam and appurtenant structures of Big Boulder Dam are probably functioning satisfactorily with the exception of undesirable seepage at the downstream toe of Dam A. The engineer is aware of this condition and is currently making plans to correct the situation. The condition of the foundations for Dams A and B could not be assessed. The resident engineer's report for Dam A stated that soft zones were covered after the surface was stabilized by dessication. In at least one place, these reports noted severe pumping action with no notation that unsuitable material was removed, which infers in place densities below specification requirements. Furthermore, control of the seepage into the blanket cutoff trench of Dam B was not defined and there was no discussion located in the engineer's files as to how fill materials were placed and compacted. A resident engineer report dated June 6, 1957, also stated that the foundation rock of Dam B was fractured with voids.

Hydrologic and hydraulic calculations presented in Appendix C indicate the dam will pass the Probable Maximum Flood without overtopping and the spillway is "Adequate".

In the event of failure, property damage along Grass Lake Creek below Dam A and farther along Tunkhannock Creek prior to its confluence with Tobyhanna Creek could be expected. Failure of Dam B into Swamp Run could produce extensive property damage and probable loss of life in the area of Albrightsville, Pennsylvania. This potential, especially along Swamp Run, clearly justifies the "High" hazard classification of this structure.

b. Adequacy of Information. The necessary information available for this investigation was sufficiently adequate to evaluate the exterior features of the dam. Since documentation pertaining to foundation preparation and fill placement were not located, an assessment of these features could not be made.

c. Urgency. It is recommended that the suggestions presented in Section 7.2 be implemented as soon as practical.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. Visual inspection and review of the construction and limited design documentation indicates that the dam and appurtenant structures of Big Boulder Dam are probably functioning satisfactorily with the exception of undesirable seepage at the downstream toe of Dam A. The engineer is aware of this condition and is currently making plans to correct the situation. The condition of the foundations for Dams A and B could not be assessed. The resident engineer's report for Dam A stated that soft zones were covered after the surface was stabilized by dessication. In at least one place, these reports noted severe pumping action with no notation that unsuitable material was removed, which infers in place densities below specification requirements. Furthermore, control of the seepage into the blanket cutoff trench of Dam B was not defined and there was no discussion located in the engineer's files as to how fill materials were placed and compacted. A resident engineer report dated June 6, 1957, also stated that the foundation rock of Dam B was fractured with voids.

Hydrologic and hydraulic calculations presented in Appendix C indicate the dam will pass the Probable Maximum Flood without overtopping and the spillway is "Adequate".

In the event of failure, property damage along Grass Lake Creek below Dam A and farther along Tunkhannock Creek prior to its confluence with Tobyhanna Creek could be expected. Failure of Dam B into Swamp Run could produce extensive property damage and probable loss of life in the area of Albrightsville, Pennsylvania. This potential, especially along Swamp Run, clearly justifies the "High" hazard classification of this structure.

b. Adequacy of Information. The necessary information available for this investigation was sufficiently adequate to evaluate the exterior features of the dam. Since documentation pertaining to foundation preparation and fill placement were not located, an assessment of these features could not be made.

c. Urgency. It is recommended that the suggestions presented in Section 7.2 be implemented as soon as practical.

7.2 Remedial Measures.

a. Facilities. The following recommendations should continue to be performed under the direction of, or reviewed by, a registered professional engineer experienced in the design of dams.

1. Seepage at the downstream toe of Embankment A should be assessed and controlled.

2. The right side of the spillway at Dam A should be monitored for increases in seepage rates or presence of turbidity. In the event either condition occurs, the condition should be reviewed immediately and appropriate action taken, if necessary.

3. Seepage noted along the downstream toe of Dam B should be monitored periodically for turbidity or increases in flow. In the event a change occurs, conditions should be reviewed and appropriate remedial measures taken.

b. Operation and Maintenance Procedures. Operation and maintenance procedures should be established as soon as possible. This procedure should include a checklist to insure that all items are carefully inspected and maintained in the best possible condition. Since the warning procedure contains provisions for monitoring the dam during periods of high flows and a procedure for warning downstream residents and evacuating procedures, if necessary, no further recommendations pertaining to this procedure are presented.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Big Boulder Dam*

ID # *PA 00615*

ITEM	REMARKS
AS-BUILT DRAWINGS	*Design drawings prepared by Justin & Courtney, Philadelphia, Pennsylvania were available in DER files and selected portions are enclosed in Appendix E.*
REGIONAL VICINITY MAP	*See Plate 1, Appendix E.*
CONSTRUCTION HISTORY	*Available data is presented in Section 1 of text*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*See Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*- None available*
RAINFALL/RESERVOIR RECORDS	*- Records are not maintained in this watershed.*

ITEM	REMARKS
DESIGN REPORTS	*None available in DER files. 1978 Engineers inspection report was available and reviewed.*
GEOLOGY REPORTS	*None available in DER files.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS	*Data not available in DER files.*
DAM STABILITY	*Data located in DER files and presented in Appendix E.*
SEEPAGE STUDIES	*Data not available in DER files.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*Logs of borings in DER files are presented in Appendix E.*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*Material obtained from and adjacent to the reservoir.*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*None*
HIGH POOL RECORDS	*No records in DER files.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None*
MAINTENANCE OPERATION RECORDS	*Records not available in DER files.*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*See Appendix E.*
MISCELLANEOUS	1. *"Application" dated March 7, 1957 and April 19, 1963* 2. *"Permit" dated May 10, 1957 and May 14, 1963* 3. *Construction status reports prepard by the Owner* 4. *13 black and white State Inspection photographs.* 5. *"Report Upon the Application of Split Rock Lodge, Inc." to install flash boards, 29 April 1963.* 6. *"Report Upon the Application of Lake Harmony Development Company" to construct a dam, May 3, 1957.* 7. *Specifications prepared by Justin & Courtney, Philadelphia, Pennsylvania*
CONSULTING ENGINEERS	*Justin & Courtney, Philadelphia, Pennsylvania. The designer was contacted and the project discussed with the inspection team.*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Big Boulder Dam* County *Carbon* State *Pennsylvania* National ID # *PA 00615*

Type of Dam *Earth* Hazard Category *I-High*

Date(s) Inspection *11 May '79* Weather *Cloudy and Cool* Temperature *High 60's*

Pool Elevation at Time of Inspection *1775±* M.S.L. Tailwater at Time of Inspection *1760* M.S.L.

Inspection Personnel:

John Boschuk, Jr. (Geotechnical) *Raymond Lambert (Geologist)* *John H. Frederick (Geotechnical)*

Mary F. Beck (Hydrologist) *Vincent McKeever (Hydroloigst)*

John Boschuk, Jr. Recorder

Remarks:

Two dams form Big Boulder Lake. Dam A has the spillway at right abutment.

Mr. Curtis W. Kemmerer was on site and provided assistance to the inspection team.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

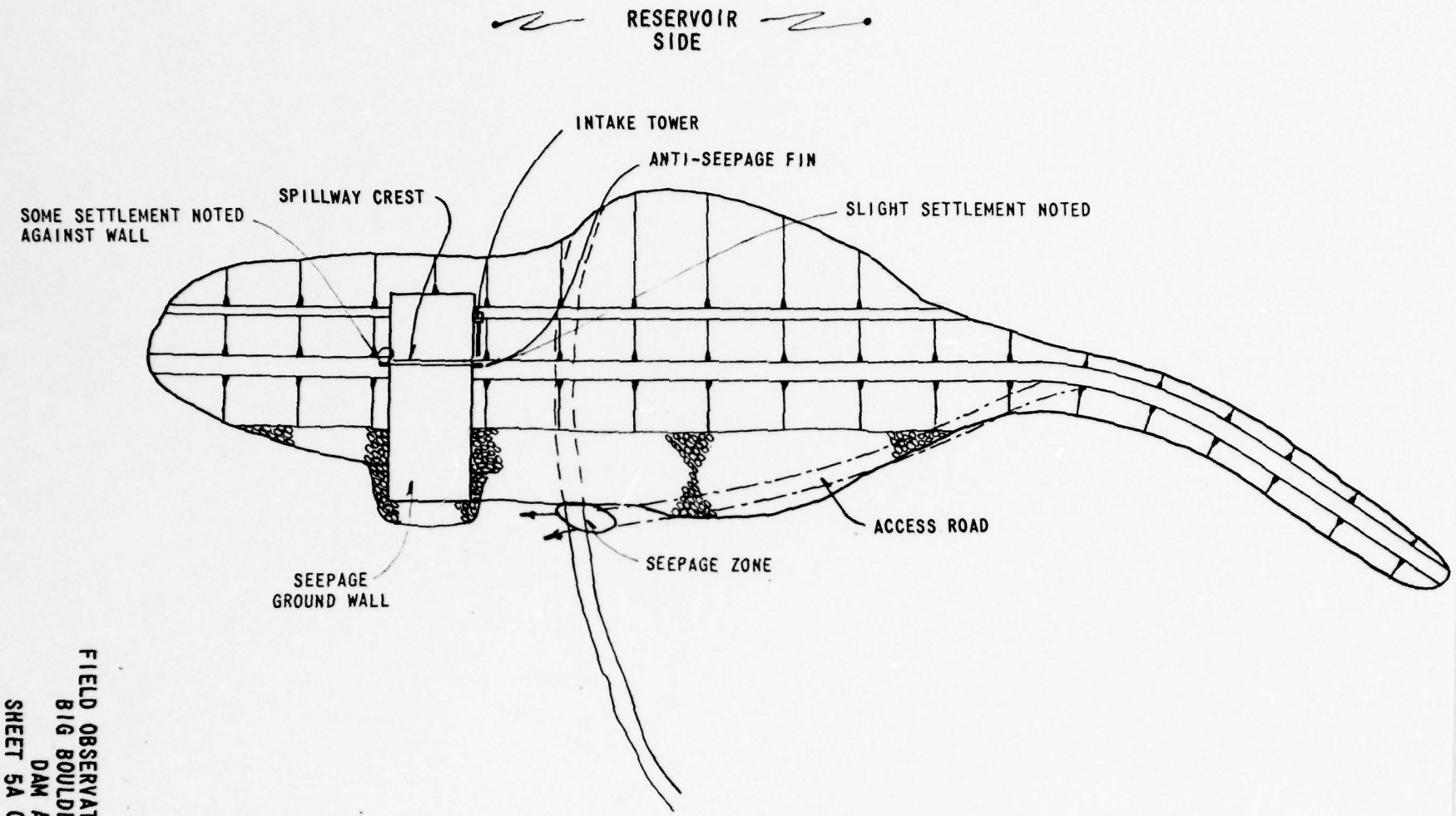
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

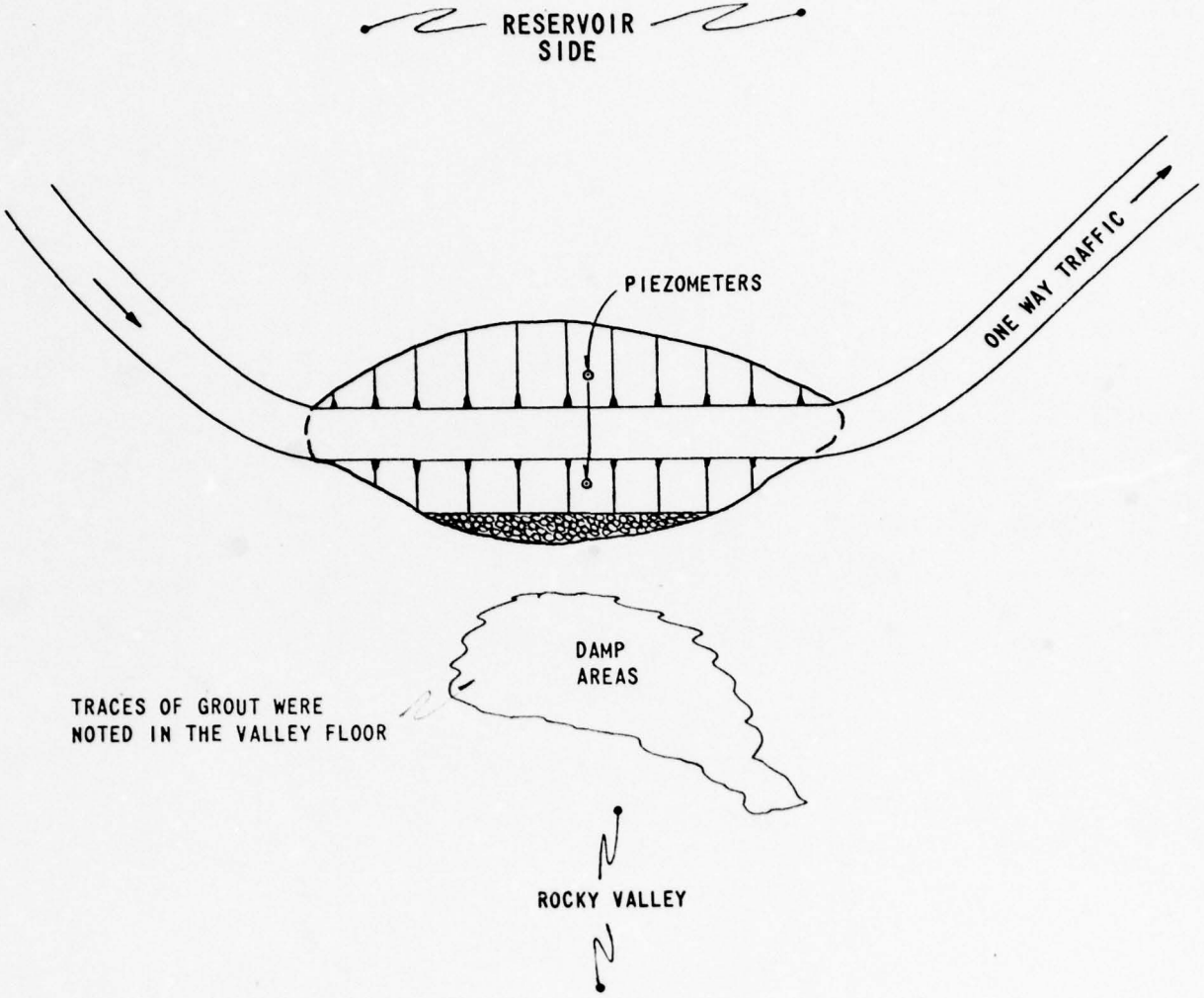
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*None observed.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*Alignment checked and found to be satisfactory.*	
RIPRAP FAILURES	*None observed.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*Good condition. The embankment is approximately 4 inches lower than the spillway antiseepage walls as shown on Photograph No. 8.*	
ANY NOTICEABLE SEEPAGE	*Yes. See Sheet 5a for the three locations of seepage observed.*	
STAFF GAGE AND RECORDER	*None.*	
DRAINS	*Yes. The drains appear to be functioning satisfactorily.*	



FIELD OBSERVATION PLAN
BIG BOULDER DAM
DAM A
SHEET 5A OF 11



FIELD OBSERVATION PLAN
BIG BOULDER DAM
DAM B
SHEET 5B OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*None observed.*	
INTAKE STRUCTURE	*Good condition.*	
OUTLET STRUCTURE	*Good condition.*	
OUTLET CHANNEL	*Good condition.*	
EMERGENCY GATE	*Valve was exercised and found to function properly.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*Good condition.*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*Good condition.*	
BRIDGE AND PIERS	*Good condition.*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*Yes. Two observation wells were installed on Dam B to monitor embankment water levels.*	
WEIRS	*One weir located a couple of hundred feet downstream to monitor stream flow.*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Reservoir side slopes are moderate, stable and well vegetated to water's edge with trees and grass.*	
SEDIMENTATION	*Little or no sedimentation, no effect on flood water storage.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*The downstream channel is about 5 feet wide, bed and banks are rocky. The banks are about 4 feet high. The flood plain is completely wooded.*	
SLOPES	*The valley gradient is about 0.02 immediately below the dam.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*A house is built adjacent to Tunkhannock Creek about 3.3 miles below the Dam A. About 0.5 miles further, the creek enters Tobyhanna Creek. About 2.3 miles below Dam B Swamp Run enters Mud Run where one house is built in flood plain. About 0.5 miles along Mud Run are at least 10 houses built in flood plain and subject to damage in the event of dam failure.*	

APPENDIX

C

BIG BOULDER DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Wooded mountain top watershed, resort lodge.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *1775 feet (920 Acre-Feet).*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *1781 feet (2090 Acre-Feet).*

ELEVATION MAXIMUM DESIGN POOL: *1778.0 feet.*

ELEVATION TOP DAM: *1781 feet.*

SPILLWAY

a. Elevation *1775 feet.*

b. Type *Concrete ogee weir.*

c. Width *56 feet including 1-14 inch thick bridge pier.*

d. Length *N/A*

e. Location Spillover *Right abutment of Dam A.*

f. Number and Type of Gates *None.*

OUTLET WORKS:

a. Type *Intake tower.*

b. Location *Left side of spillway.*

c. Entrance inverts *4 inch at 1768 feet, 2 feet at 1765 feet.*

d. Exit inverts *Discharge through spillway wall downstream of weir.*

e. Emergency draindown facilities *2 feet discharge conduit.*

HYDROMETEOROLOGICAL GAGES:

a. Type *Rainfall and snow gage.*

b. Location *Big Boulder Lodge.*

c. Records *Maintaned by the Owner.*

MAXIMUM NON-DAMAGING DISCHARGE: *Not determined.*

HEC-1, REVISED
FLOOD HYDROGRAPH PACKAGE

The original "Flood Hydrograph Package" (HEC-1), developed by the Hydrologic Engineering Center, Corps of Engineers, has been modified for use under the National Dam Inspection Program. The "Flood Hydrograph Package (HEC-1), Dam Safety Version", hereinafter referred to as, HEC-1, Rev., has been modified to require less detailed input and to include a dam breach analysis. The required input is obtained from the field inspection of a dam, any available design/evaluation data, relatively simple hydraulic calculations, or information from the USGS Quandrangle maps. The input format is flexible in order to reflect any unique characteristics of an individual dam.

HEC-1, Rev. computes a reservoir inflow hydrograph based on individual watershed characteristics such as: area, percentage of impervious surface area, watershed shape, and hydrograph characteristics determined from regional correlation studies by the Corps of Engineers, Baltimore District. The inflow is routed through the reservoir using spillway discharge data obtained from the field inspection or design data. Flood storage capacity is determined from USGS maps or design information and verified by the field inspection. In the event a spillway cannot discharge 0.5 PMF without overtopping and failure of the dam, downstream channel characteristics obtained from the field inspection and USGS maps are inputed and flows are routed downstream to the damage center and a dam breach analysis is performed.

Included in this Appendix are the HEC-1, Rev. pertinent input values and a summary print-out tables.

Classification (Ref. - Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is rated as "High" as there would be loss of life if the dam failed.

2. The size classification is "Intermediate" based on its 1971 Ac-Ft total storage capacity (to embankment low point).

3. The spillway design flood, based on size and hazard classification, is the Probable Maximum Flood (PMF).

Hydrology and Hydraulic Analysis

1. Original / Evaluation Data.

Original Data - Justin & Courtney preliminary report, spillway designed for Q = 1100 cfs w/ H = 3ft. Drainage area = 1.2 sq. miles. The State's "Application Report", spillway discharge is 2860 cfs and is satisfactory. Also included in the State's files, 3 sheets of calculations.

Drainage Area = 1.2 sq miles
Peak Inflow = 3000 cfs
Rainfall = 24 inches w/ 100% runoff
Storage in Round Pond included in flood storage capacity
Maximum outflow = 1050 cfs at 1778 ft.

Evaluation Data

1963 request to use splash boards, State evaluation

w/o splash boards

$Q = CLH^{3/2}$
$= 3.88 \cdot 56 \cdot 5^{3/2}$
$= 2430$ cfs

w/ splash boards

$Q = 3.3 \cdot 56 \cdot 4.5^{3/2}$
$= 1760$ cfs

Request approved

1963 request to increase height of splash boards

$Q = 3.3 \cdot 56 \cdot 4^{3/2}$
$= 1478$ cfs

Request refused

Evaluation Data (con't)

1978 evaluation by Justin & Courtney included a HEC-1 computer run and some back-up calculations. The evaluation concluded the structure could pass 0.84 PMF w/ splash boards in place and not overtop the embankments. The drainage area was determined from current USGS maps to be 1.65 sq. miles. The HEC-1 computed peak inflow was 8500 cfs. for 6-hr, 25 inch rainfall using the Hop Brook factor.

2. Evaluation - as all of the 1978 Justin & Courtney evaluation data was not available for review and as the peak PMF value was judged conservative, it was decided to evaluate the structure by the use of the HEC-1, Dam Safety Version, computer program and hydrologic criteria established by the Corps of Engineers, Baltimore District, for this investigation.

Inflow Hydrograph

drainage area - measured from USGS map, confirms the 1.65 sq. mile area.

rainfall - shown on sheet 8, Ref. - Hydrometerological Report No. 33.

Snyder's hydrograph parameters, t_p & C_p

$t_p = C_t (L')^{0.6}$

$C_t = 1.23$ Information supplied from Corps of Engineers, Baltimore, for Zone 1

$C_p = 0.45$

$L' = 1.23$ miles - distance from upper end of reservoir to watershed divide. This form of Snyder's equation used as the watershed center of gravity is very near the upper end of reservoir.

$t_p = 1.23 \cdot 1.23^{0.6} = 1.39$

Note: Although Big Boulder watershed is located in Zone 2, the physical characteristics of the watershed are those of a Zone 1 watershed. Therefore, it has been conservatively decided to use Zone 1 input parameters for the inflow hydrograph.

BY MEB DATE 6/29/79 SUBJECT Big Boulder Dam Hydrology / Hydrauli SHEET 5 OF 11

CHKD. BY DATE JOB No.

Reservoir Routing

elevation - storage, shown on sheet 9, flood storage was estimated from USGS map, neglecting potential storage in Round Pond.

normal storage - from DER files

elevation - discharge, shown on sheet 9.

ogee weir discharge - Ref - Chow, Open Channel Hydraulics, p. 364

w/o splashboards

$X^n = K H_d^{n-1} Y$

H_d = design head excluding approach velocity head

$n = 1.85$

$K = 2.00$

from drawing

elev.	dist. from axis	X	Y	calc. H_d
1775.	3'3¾"	0	0	
1774.54	4'10¾"	1.58	0.46	2.98
1772.24	7'7¼"	4.29	2.76	3.19
1771.07	8'6"	5.19	3.93	3.18
1770.	9'4"	6.02	5.0	3.31

$X^{1.85} = 2.0 H_d^{0.85} Y$ use $H_d = 3.20$ ft.

$L = L' - 2(NK_p + K_a) H_e$ Ref - Design of Small Dams, USBR, p. 373

H_e = total head on crest

K_p = pier contraction coefficient = 0.02

N = number of piers = 1

L' = net length = 56' - 1.17' = 54.83'

K_a = abutment contraction coefficient = 0.1

$Q = C L H^{3/2}$

Assume no approach velocity head

at $H_d = 3.2$ ft P (height of weir) = 7 ft.

$P/H_o = 7/3.2 = 2.19$ $C_o = 3.9$ ft

@ $H = 3$ ft

$Q = 54.11 \cdot 3.90 \cdot 3^{3/2}$

$= 1096$ cfs

discharge w/ splashboards, shown on sheet 11

crest @ 1775.5 ft although normal pool remains at 1775. Spillway discharge assumed to remain constant when reservoir head up on bridge.

$Q = L C H^{3/2}$

$C = 3.1$ assumed

BY MFB DATE 2/11/79 SUBJECT Big Boulder Dam Hydrology/Hydraulics SHEET 6 OF 11

CHKD. BY DATE JOB No.

Overtopping Potential, see sheets 10 & 11
The maximum reservoir level during a PMF event (w/o splash boards) is about 1779.6 ft., below the underside of the bridge. With the splash boards are in place, the estimated maximum reservoir level is 1780.79, or 0.39 ft. above the embankment low point.

Spillway Adequacy; without the splash boards, the spillway is rated as "Adequate". With the splash boards and existing conditions, the spillway rating becomes "Inadequate" as the embankment is overtopped by the PMF. This investigation concurs with O'Brien & Gere's 1978 recommendation that splash boards should not be used.

MFB 2/9/79 Big Boulder Dam Hydrology / Hydraulics Sh. 7 of 11

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT IN
ROUTE HYDROGRAPH TO OUT
END OF NETWORK

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE= 79/07/10.
TIME= 05.56.26.

BIG BOULDER DAM
NAT ID NO. PA 00615 DER NO. 13-93
OVERTOPPING ANALYSIS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
150	0	15	0	0	0	0	0	-4	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .50 .80 .90 1.00

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SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
IN	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.65	0.00	1.65	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.50	111.00	124.00	134.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.39 CP= .45 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 51 END-OF-PERIOD ORDINATES, LAG= 1.40 HOURS, CP= .45 VOL= 1.00

23.	84.	169.	256.	320.	343.	325.	290.	260.	232.
207.	185.	166.	148.	132.	118.	106.	95.	85.	76.
68.	60.	54.	48.	43.	39.	34.	31.	28.	25.
22.	20.	18.	16.	14.	13.	11.	10.	9.	8.
7.	6.	6.	5.	5.	4.	4.	3.	3.	3.
2.									

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.56	23.18	2.38	94600.
										(649.)	(589.)	(60.)	(2678.77)

MFB 7/9/79 Big Boulder Dam Hydrology / Hydraulics Sh. 9 of 11

HYDROGRAPH ROUTING

OUTFLOW HYDROGRAPH W/O SPLASH BOARDS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUT	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1775.	-1

STAGE	1775.00	1776.00	1777.00	1778.00	1780.00	1782.00
FLOW	0.00	189.00	552.00	1096.00	2524.00	4144.00

Effect of foot bridge has been neglected

CAPACITY=	920.	1878.	6508.
ELEVATION=	1775.	1780.	1800.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1775.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1780.4	0.0	0.0	0.

CREST LENGTH	0.	40.	460.	620.
AT OR BELOW ELEVATION	1780.4	1780.9	1781.3	1781.4

MFB 7/11/79 Big Boulder Dam Hydrology / Hydraulics SH. 10 OF 11

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .50	RATIO 2 .80	RATIO 3 .90	RATIO 4 1.00
HYDROGRAPH AT	IN	1.65	1	2036.	3258.	3665.	4072.
	(	4.27)	(	57.66)(	92.25)(	103.78)(	115.31)(
ROUTED TO	OUT	1.65	1	974.	1817.	2095.	2370.
	(	4.27)	(	27.58)(	51.45)(	59.32)(	67.10)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	Embankment
ELEVATION	1775.00	1775.00	1780.40	low point
STORAGE	920.	920.	1971.	
OUTFLOW	0.	0.	2848.	

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1777.78	0.00	1452.	974.	0.00	44.00	0.00
.80	1779.01	0.00	1688.	1817.	0.00	43.50	0.00
.90	1779.40	0.00	1763.	2095.	0.00	43.50	0.00
1.00	1779.78	0.00	1837.	2370.	0.00	43.50	0.00

MFB 7/11/79 Big Boulder Dam Hydrology/Hydraulics Sh. 11 of 11

OUTFLOW HYDROGRAPH W/ SPLASH BOARDS

STAGE	1775.00	1776.00	1777.00	1778.00	1780.00	1781.00
FLOW	0.00	60.00	309.00	663.00	1587.00	1587.00

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1775.00	1775.00	1780.40
STORAGE	920.	920.	1971.
OUTFLOW	0.	0.	1587.

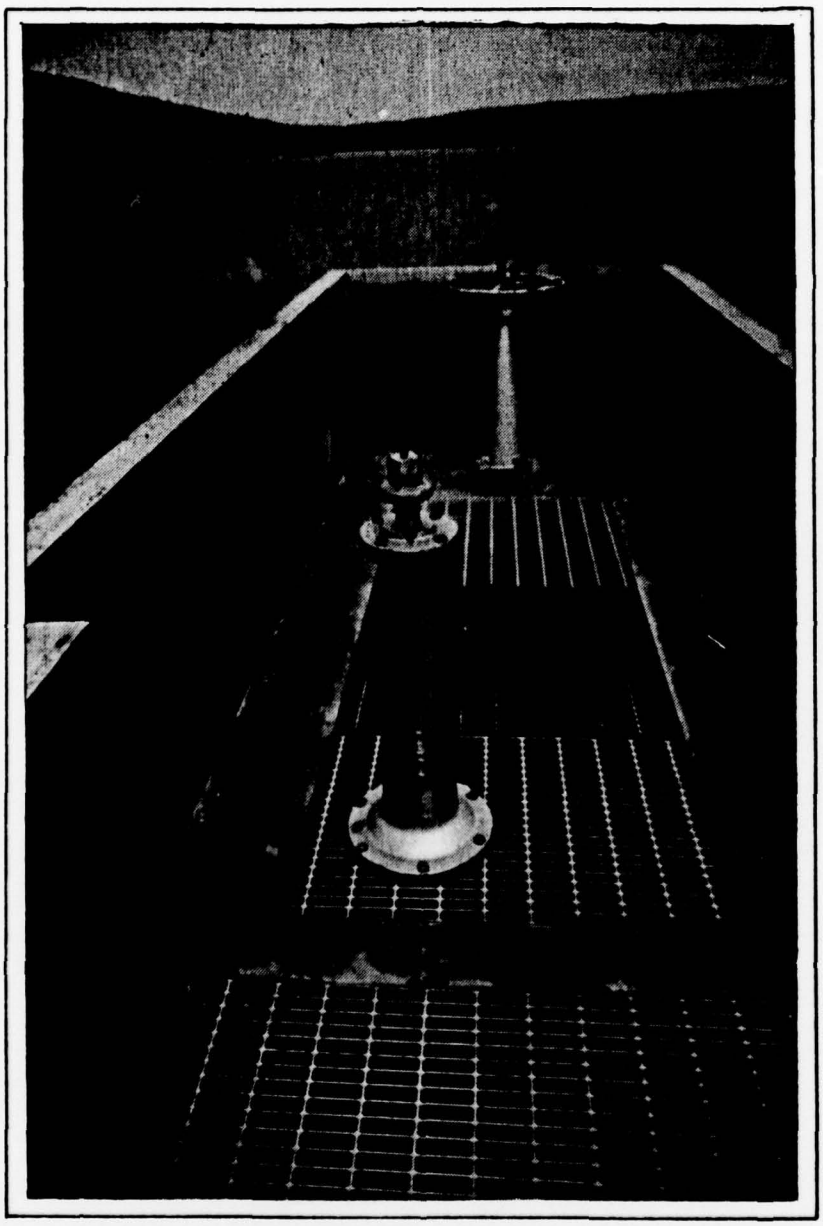
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1778.28	0.00	1549.	793.	0.00	44.50	0.00
.80	1779.77	0.00	1834.	1481.	0.00	44.00	0.00
.90	1780.25	0.00	1936.	1587.	0.00	43.00	0.00
1.00	1780.79	.39	2060.	1595.	3.75	44.50	0.00

APPENDIX

D

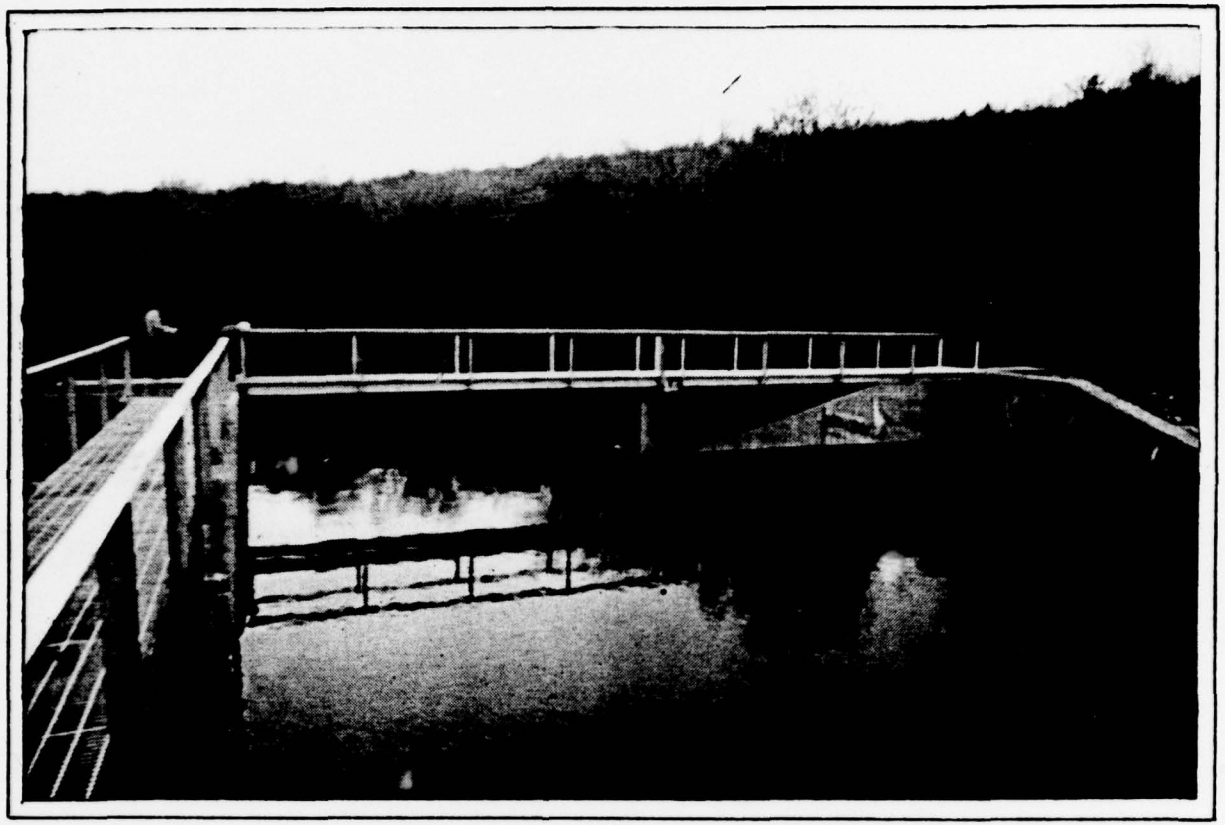
OVERVIEW OF INTAKE STRUCTURE.

PHOTOGRAPH NO. 1



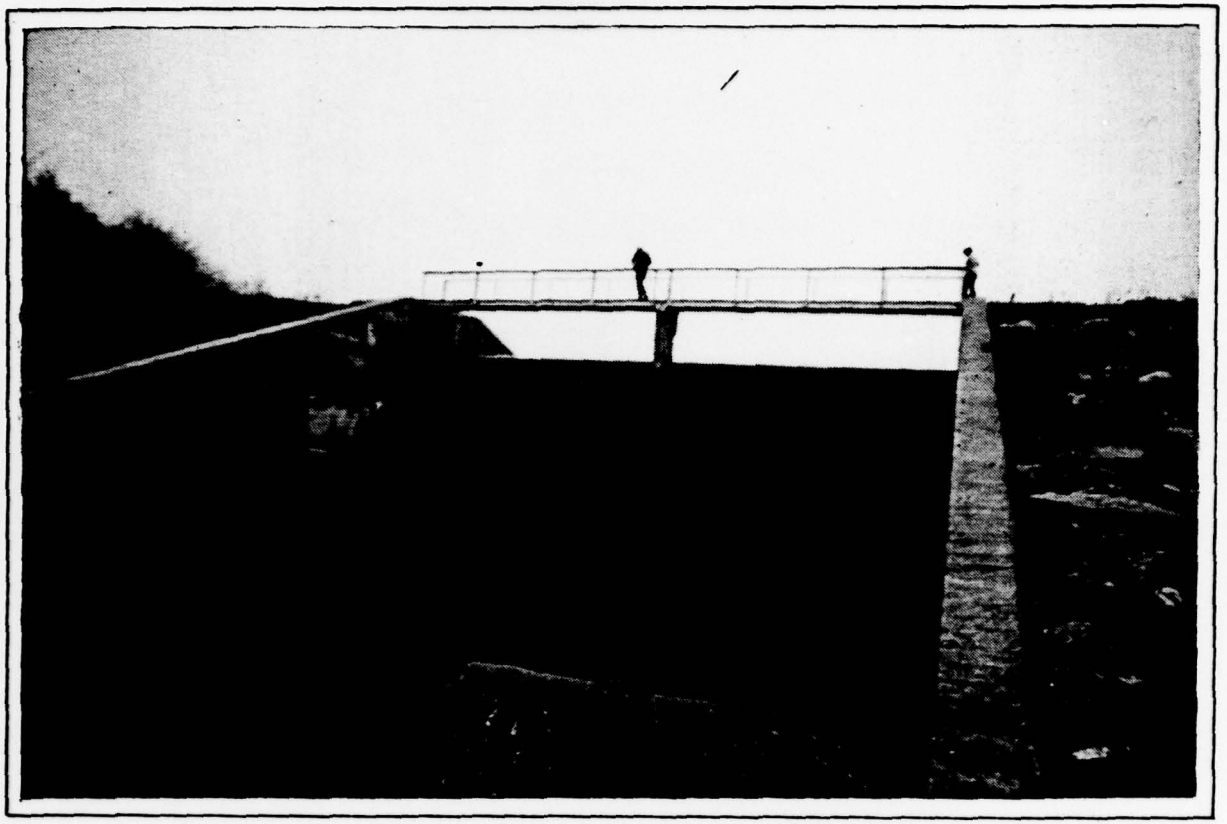
CONTROL VALVES AT TOP OF
INTAKE STRUCTURE.

PHOTOGRAPH NO. 2



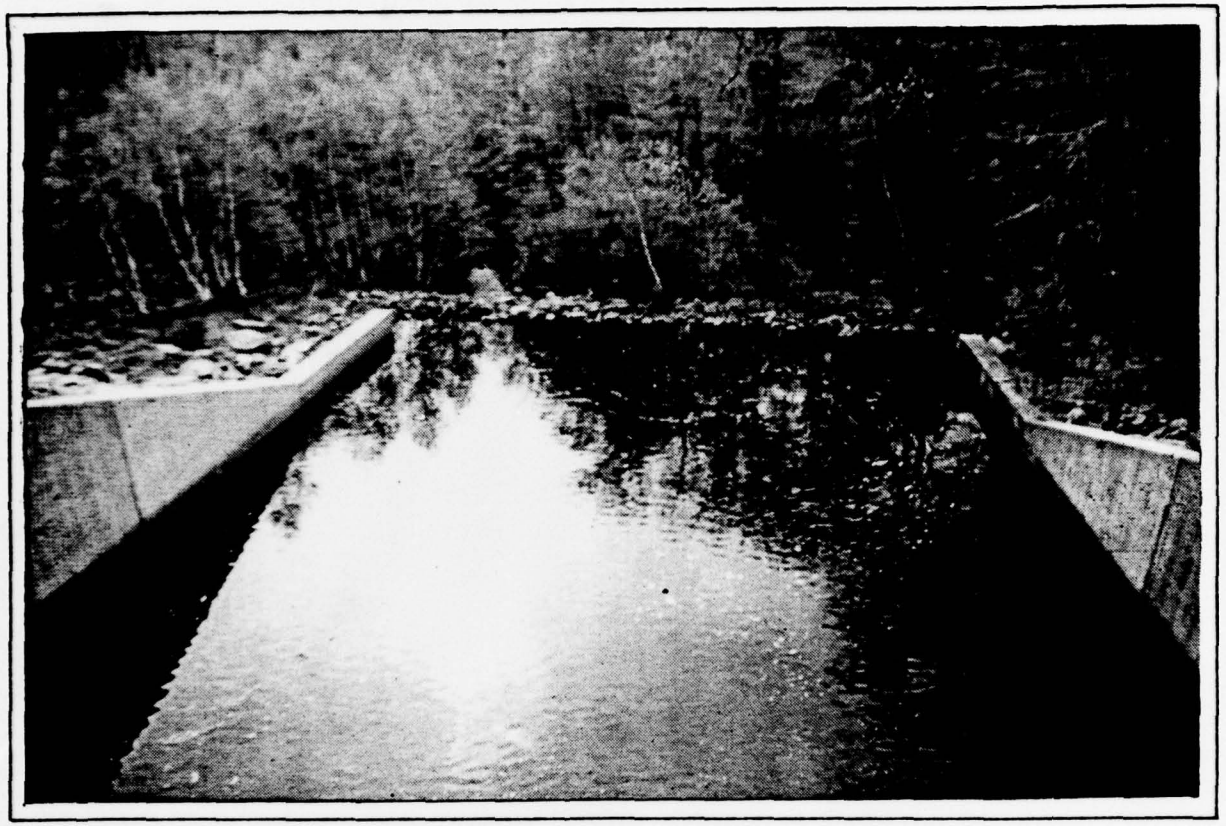
UPSTREAM VIEW OF SPILLWAY.

PHOTOGRAPH NO. 3



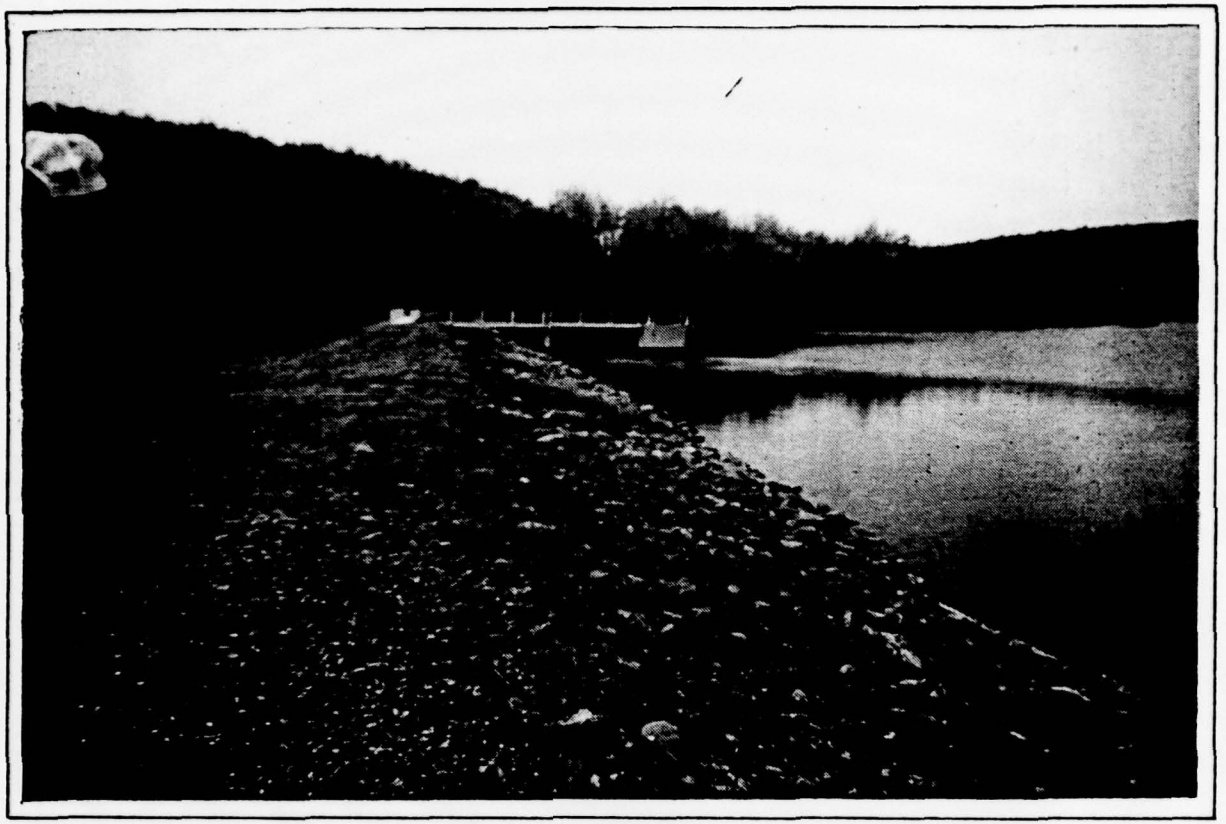
DOWNSTREAM VIEW OF SPILLWAY.

PHOTOGRAPH No. 4



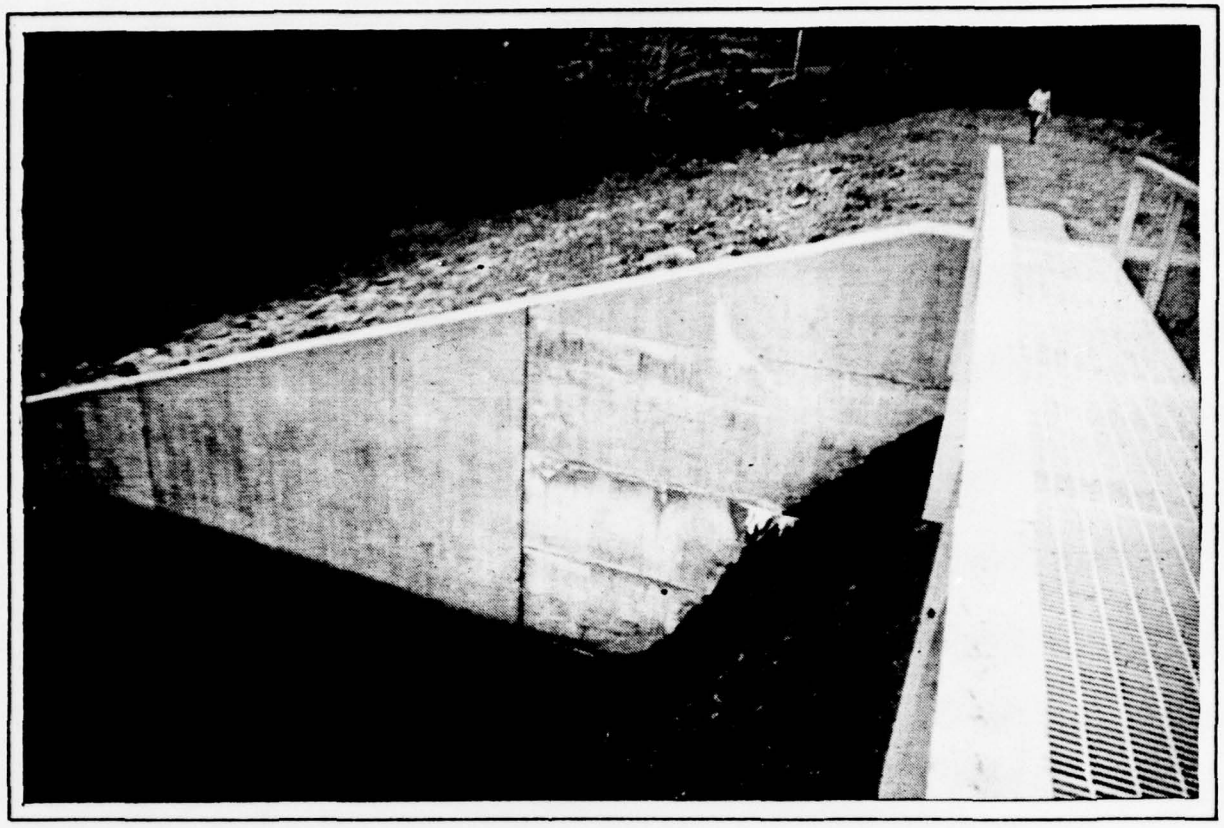
OVERVIEW OF SPILLWAY STILLING
POOL.

PHOTOGRAPH NO. 5



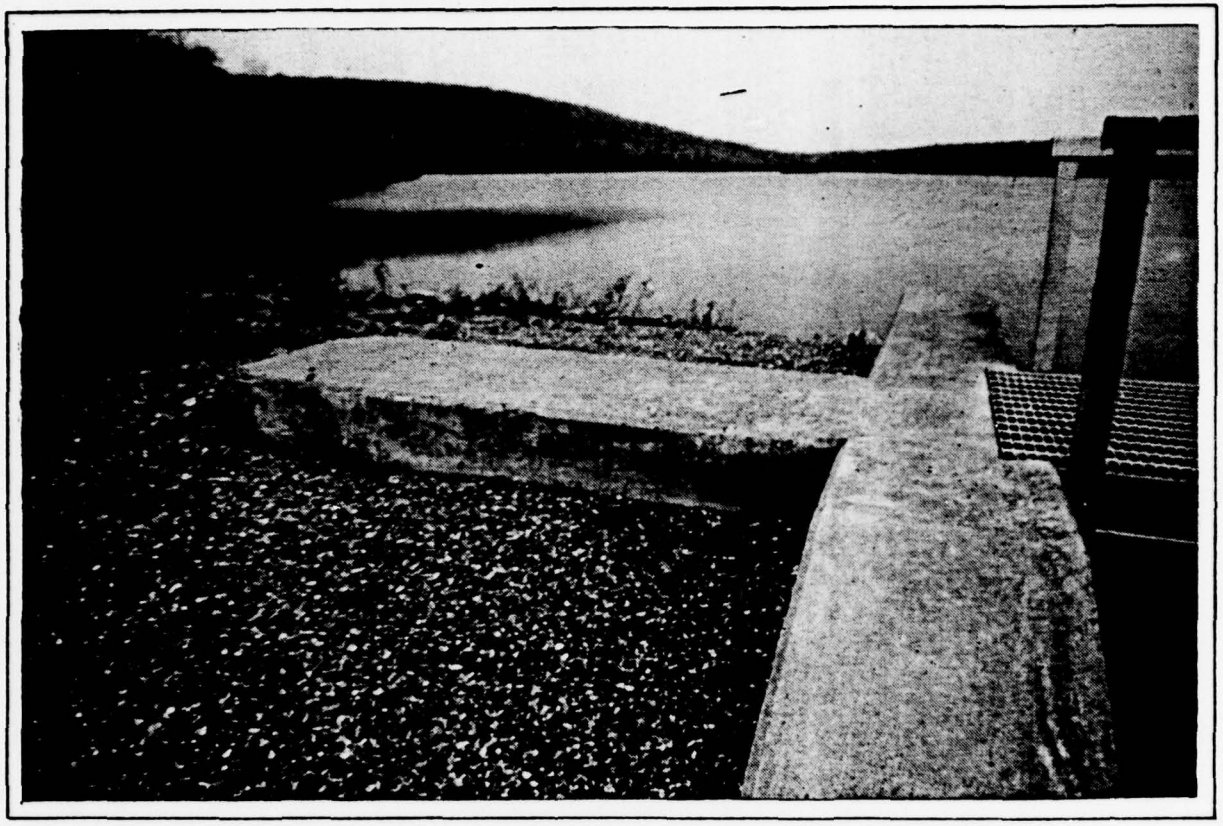
VIEW OF UPSTREAM SLOPE AND CREST
LOOKING FROM LEFT END OF DAM.

PHOTOGRAPH NO. 6



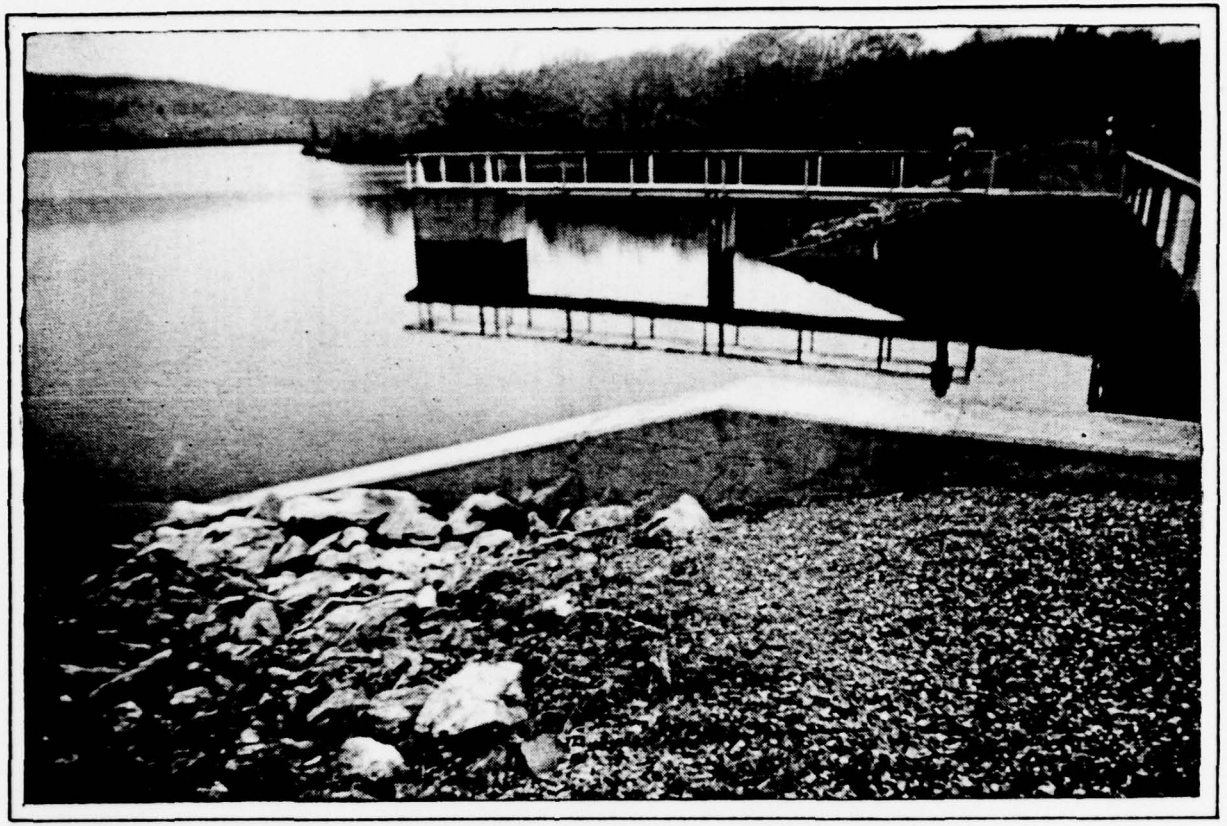
RIGHT WALL OF SPILLWAY LOOKING
FROM THE LEFT WALL.

PHOTOGRAPH NO. 7



TOP OF RIGHT RETAINING WALL OF SPILLWAY.
NOTE DIFFERENCE IN EMBANKMENT AND WALL
HEIGHT.

PHOTOGRAPH NO. 8

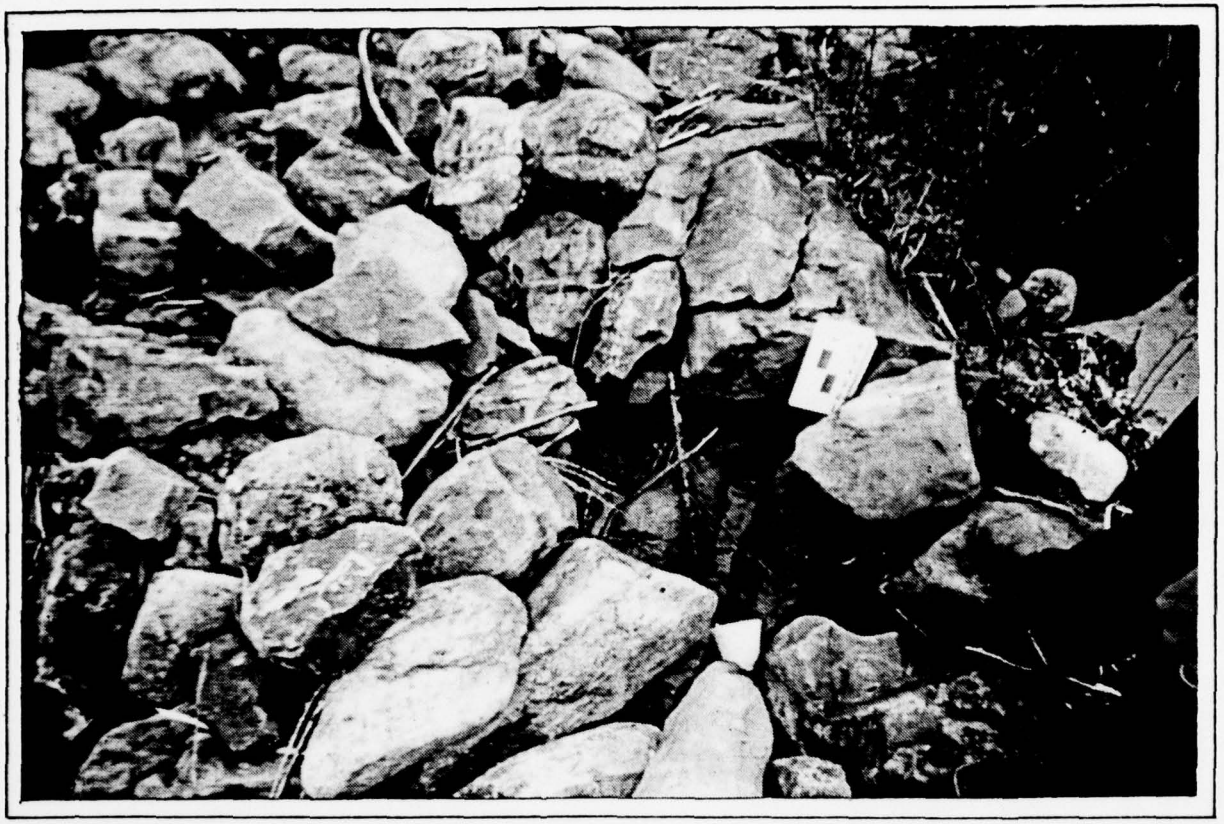


VIEW OF SPILLWAY WALL/EMBANKMENT
CONTACT.

PHOTOGRAPH NO. 9

OVERVIEW OF SEEPAGE THROUGH
DOWNSTREAM TOE ON LEFT SIDE
OF SPILLWAY.

PHOTOGRAPH NO. 10



POINT OF SEEPAGE EMERGENCE THROUGH
TOE OF DAM.

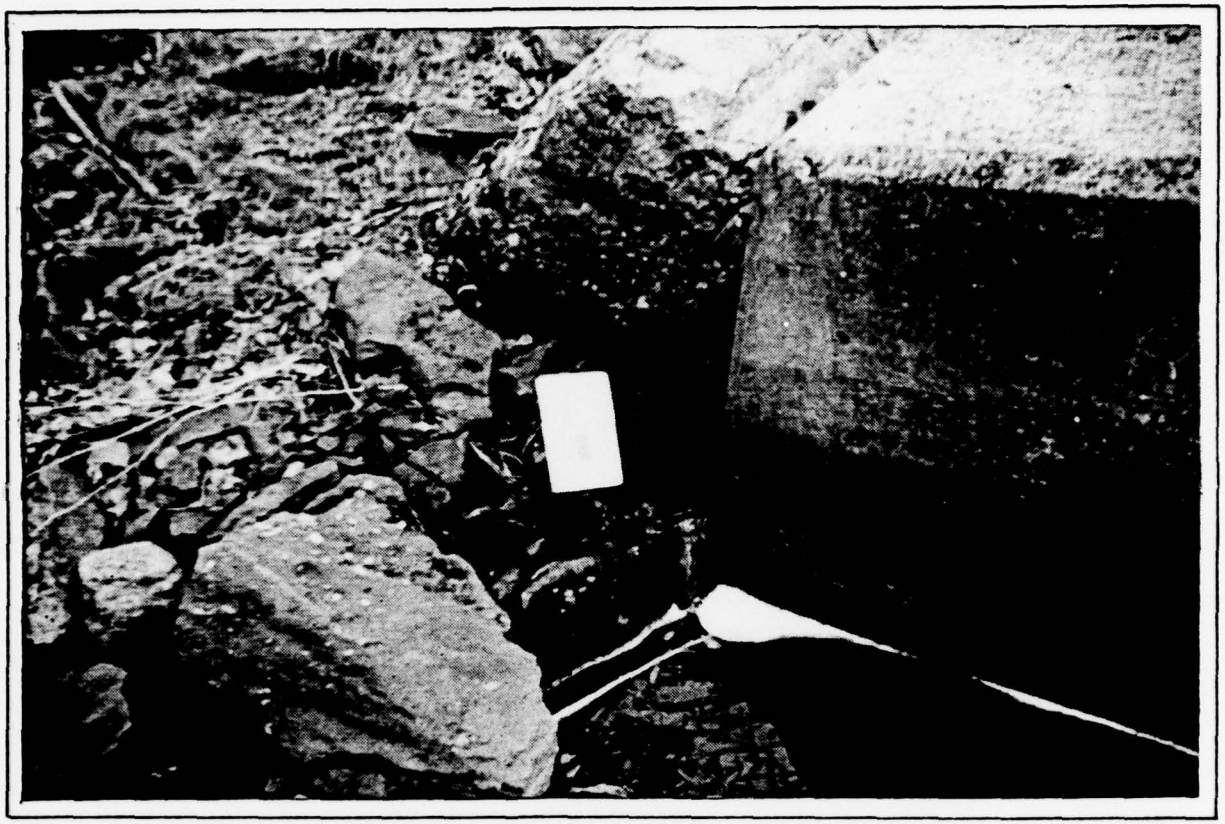
PHOTOGRAPH NO. 11

POINT OF SEEPAGE EMERGENCE THROUGH
TOE OF DAM.

PHOTOGRAPH NO. 11

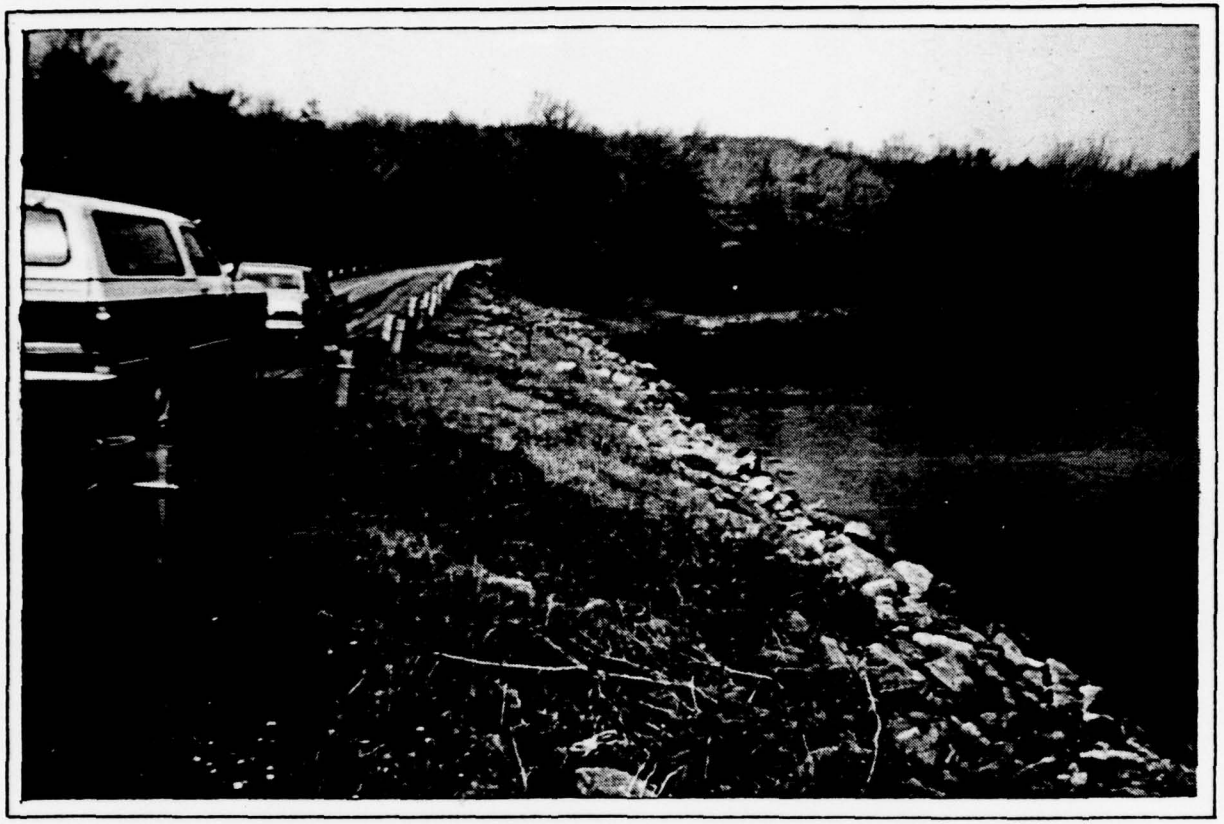
RECENTLY CONSTRUCTED ACCESS ROAD ALONG DOWNSTREAM TOE. ROADWAY USED FOR ACCESS TO SEEPAGE ZONE.

PHOTOGRAPH NO. 12



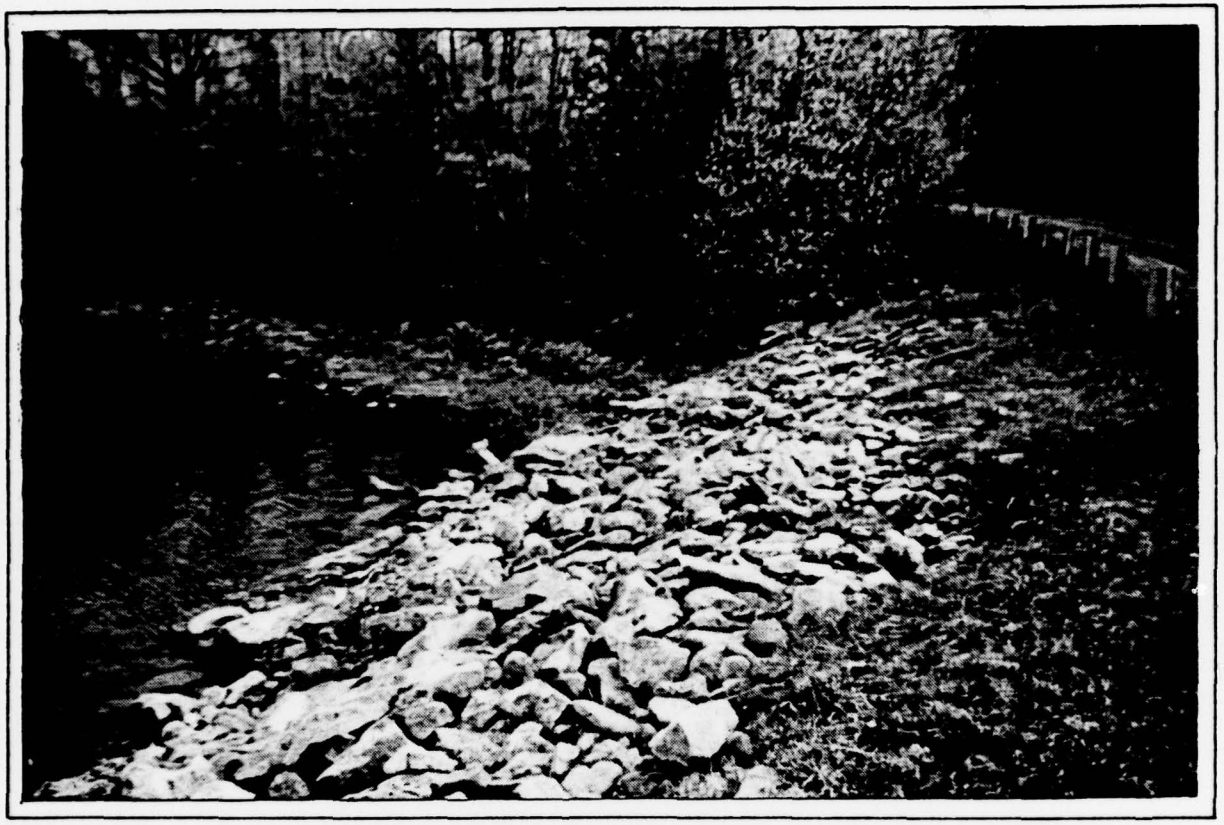
SEEPAGE THROUGH DAM TOE DISCHARGING
ALONG RIGHT RETAINING WALL OF SPILLWAY.

PHOTOGRAPH NO. 13



VIEW OF UPSTREAM SLOPE OF DAM B.

PHOTOGRAPH NO. 14



VIEW OF UPSTREAM SLOPE OF DAM B LOOKING
TOWARDS LEFT ABUTMENT.

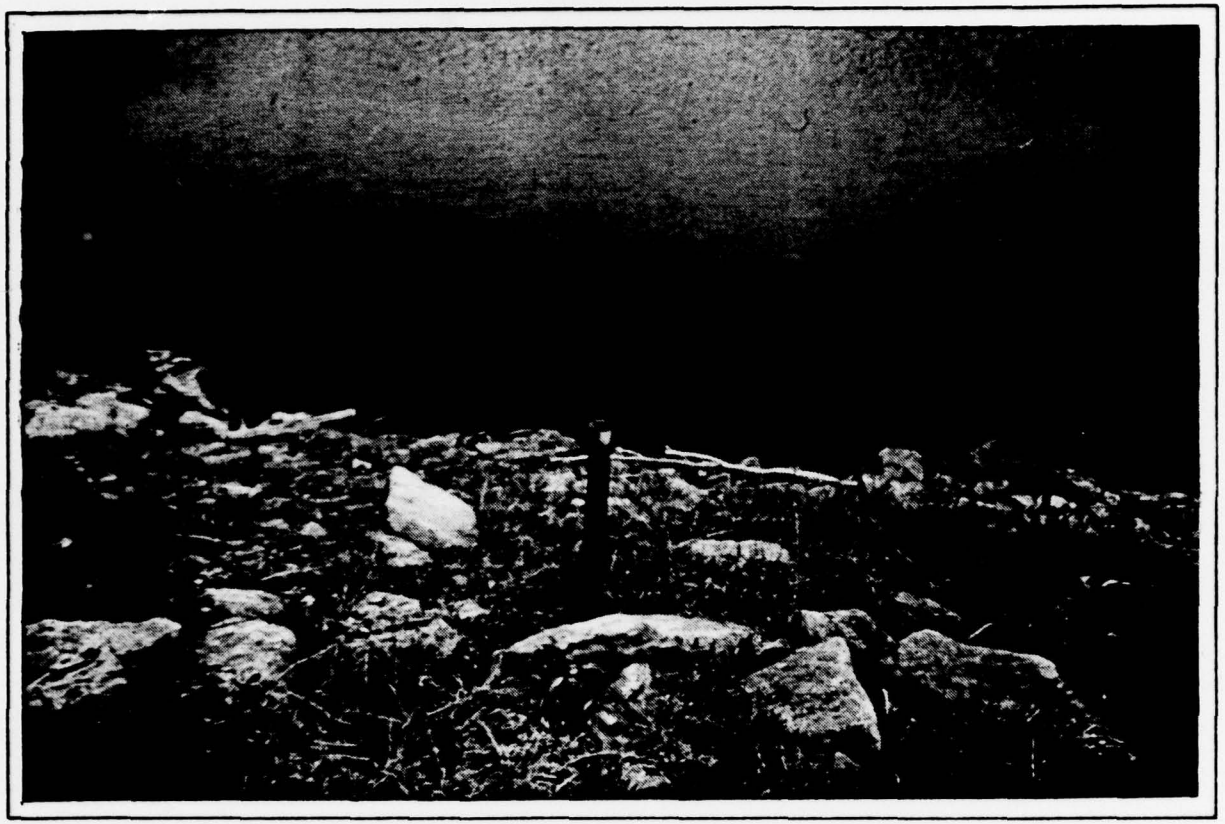
PHOTOGRAPH NO. 15

OVERVIEW OF DOWNSTREAM SLOPE OF DAM B.

PHOTOGRAPH NO. 16

DOWNSTREAM OF DAM B SHOWING LOCATION
WHERE SEEPAGE OCCURRED UNTIL IT WAS
CONTROLLED BY MEANS OF GROUTING.

PHOTOGRAPH NO. 17



OBSERVATION WELL LOCATED IN
UPSTREAM SECTION OF DAM B's
EMBANKMENT.

PHOTOGRAPH NO. 18

APPENDIX

E

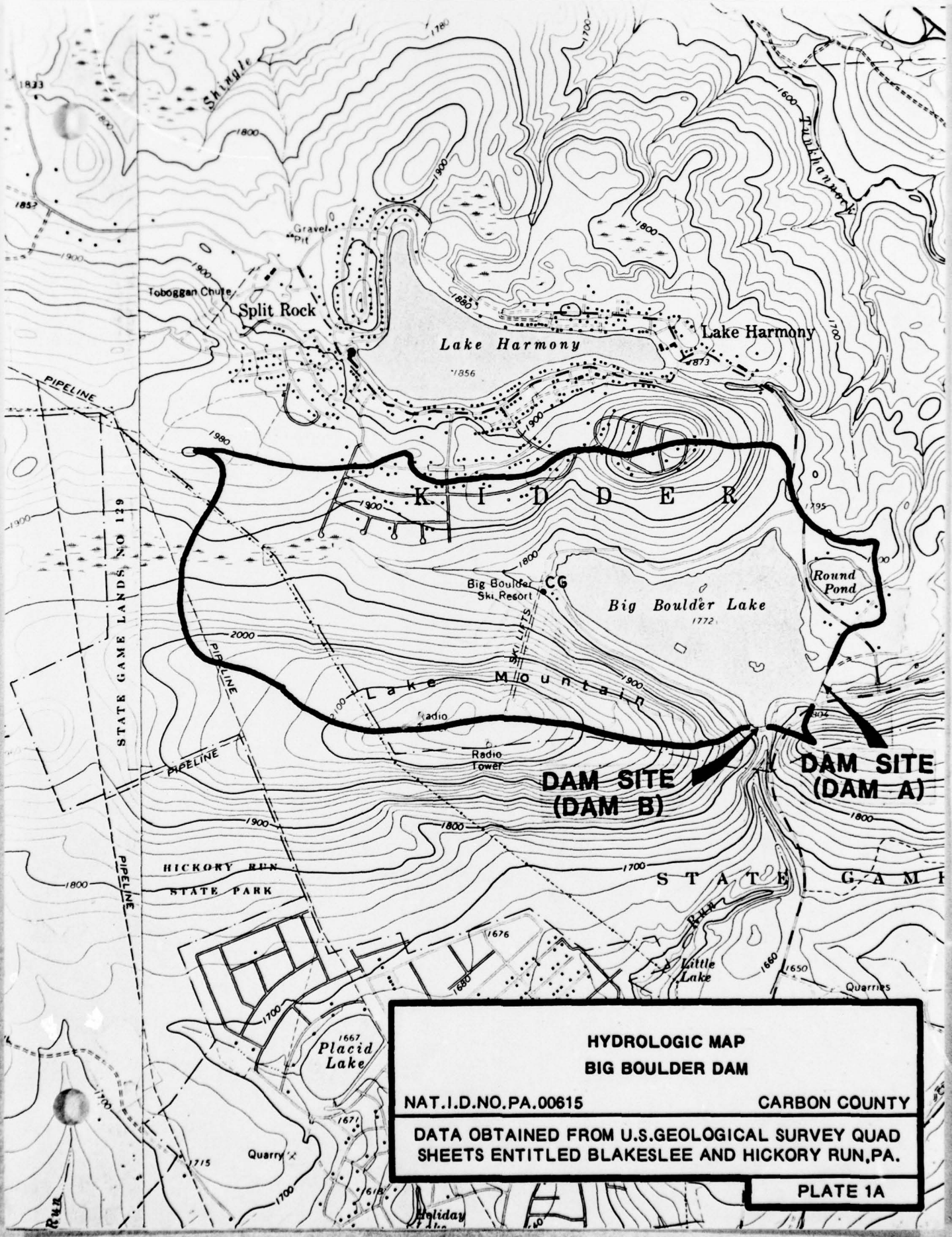
REGIONAL LOCATION PLAN

BIG BOULDER DAM

NAT.I.D.NO.PA.00615 CARBON COUNTY

DATA OBTAINED FROM U.S. GEOLOGICAL SURVEY MAP ENTITLED BLAKESLEE,PA.

PLATE 1

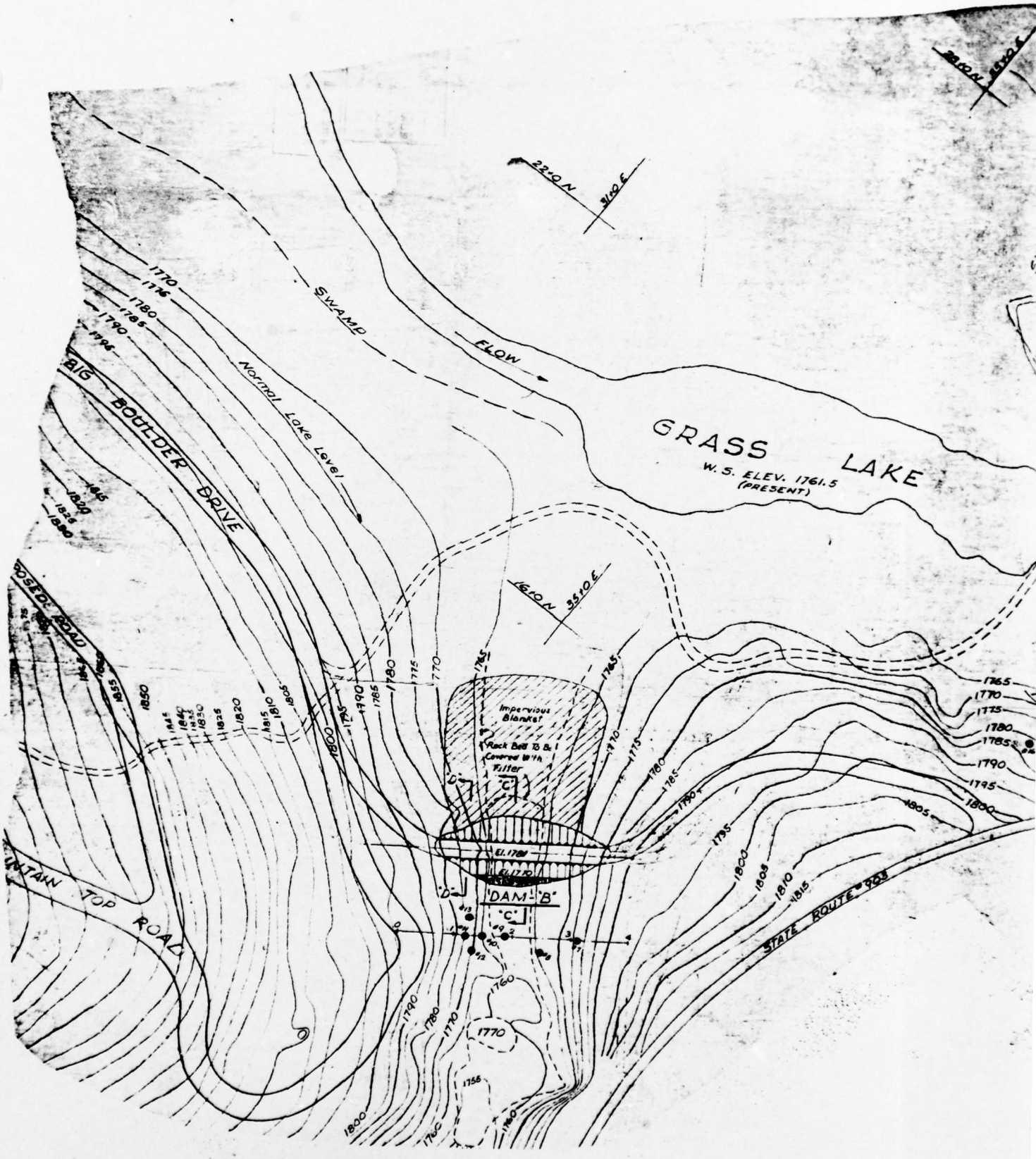


HYDROLOGIC MAP
BIG BOULDER DAM

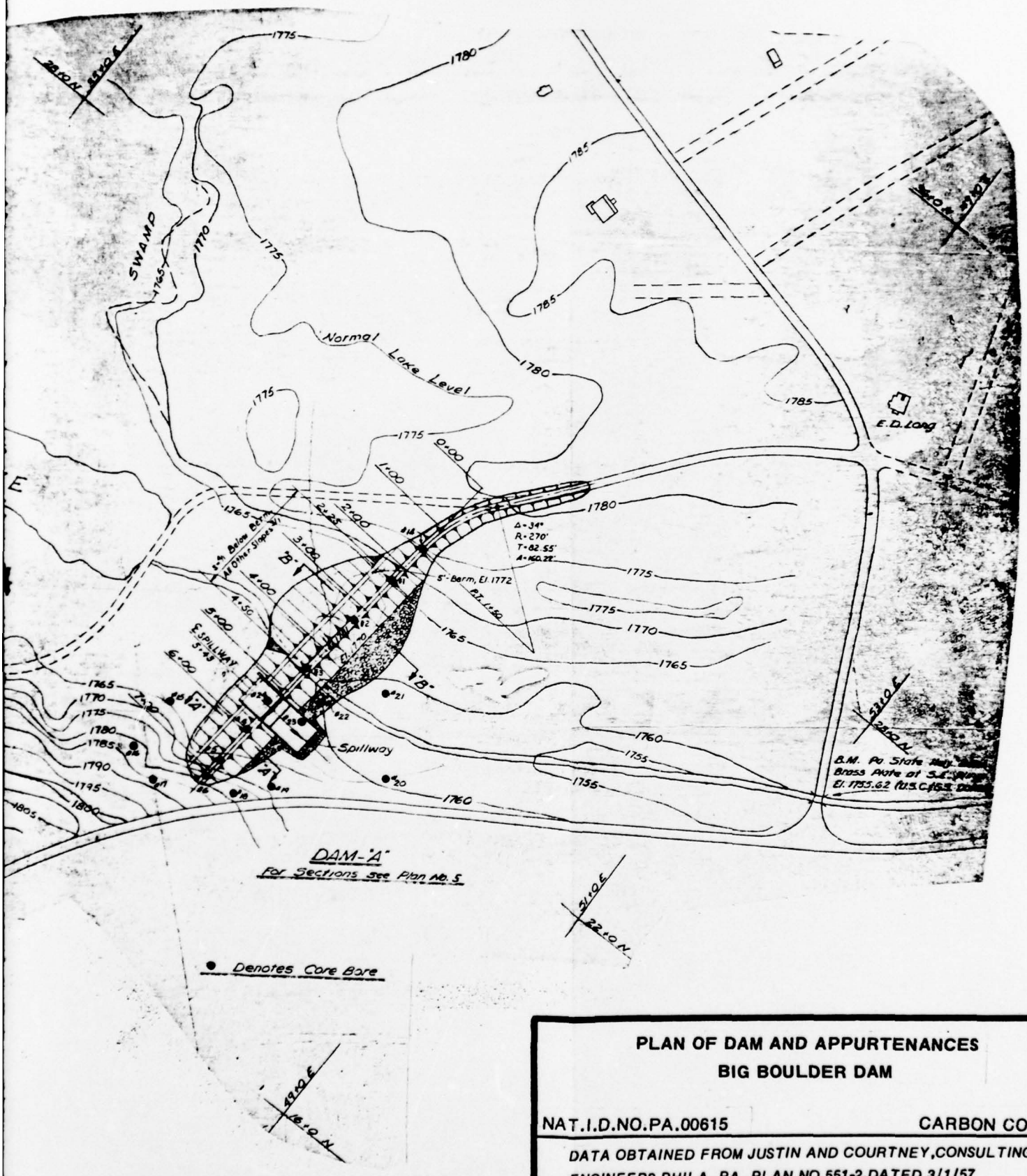
NAT.I.D.NO.PA.00615 **CARBON COUNTY**

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEETS ENTITLED BLAKESLEE AND HICKORY RUN,PA.

PLATE 1A


GRASS LAKE
W. S. ELEV. 1761.5
(PRESENT)
SWAMP
FLOW
Normal Lake Level
BIG BOULDER DRIVE
POSED ROAD
MOUNTAIN TOP ROAD
STATE ROUTE 903
DAM "B"
"C"
"D"
Impervious Blanket
Rock Belt To Be Covered With Filter
El. 1780
El. 1770
22+0 N 31+0 E
16+0 N 35+0 E
1770
1775
1780
1785
1790
1795
1800
1805
1810
1815
1820
1825
1830
1835
1840
1845
1850
1855
1760
1740
1756

1

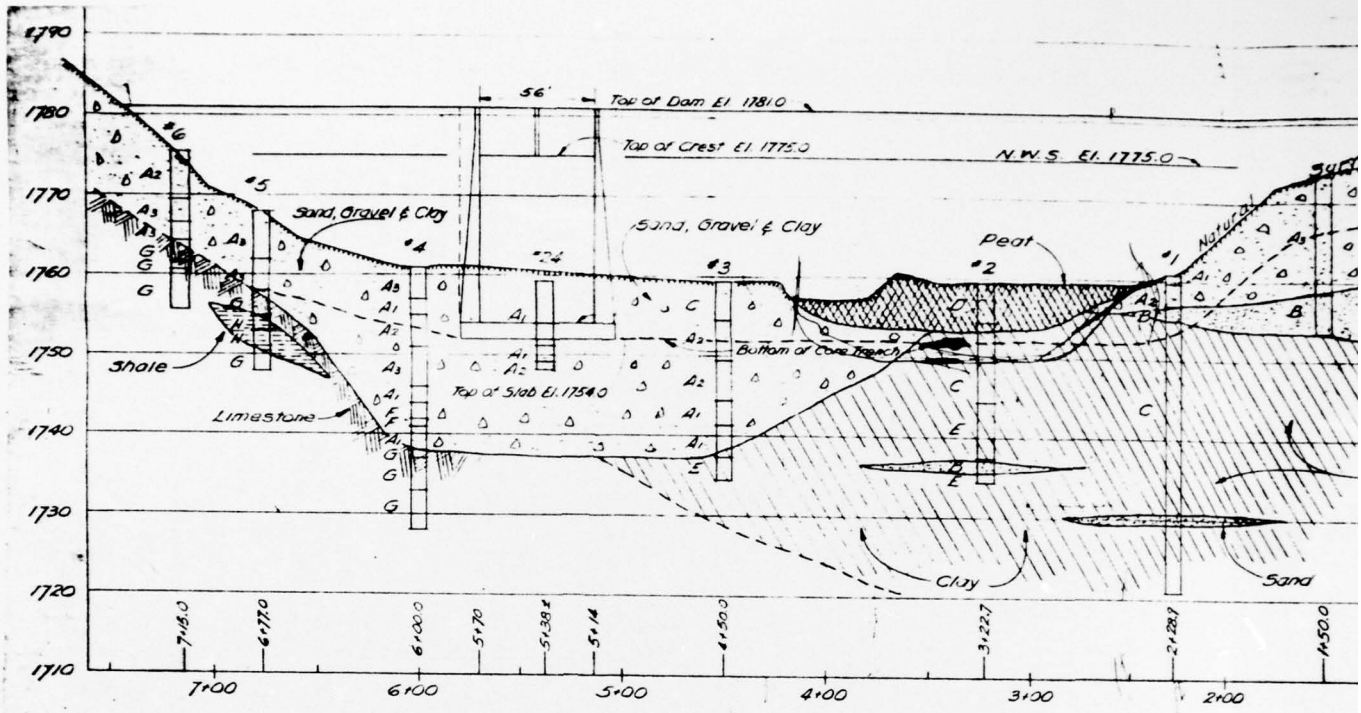


PLAN OF DAM AND APPURTENANCES
BIG BOULDER DAM

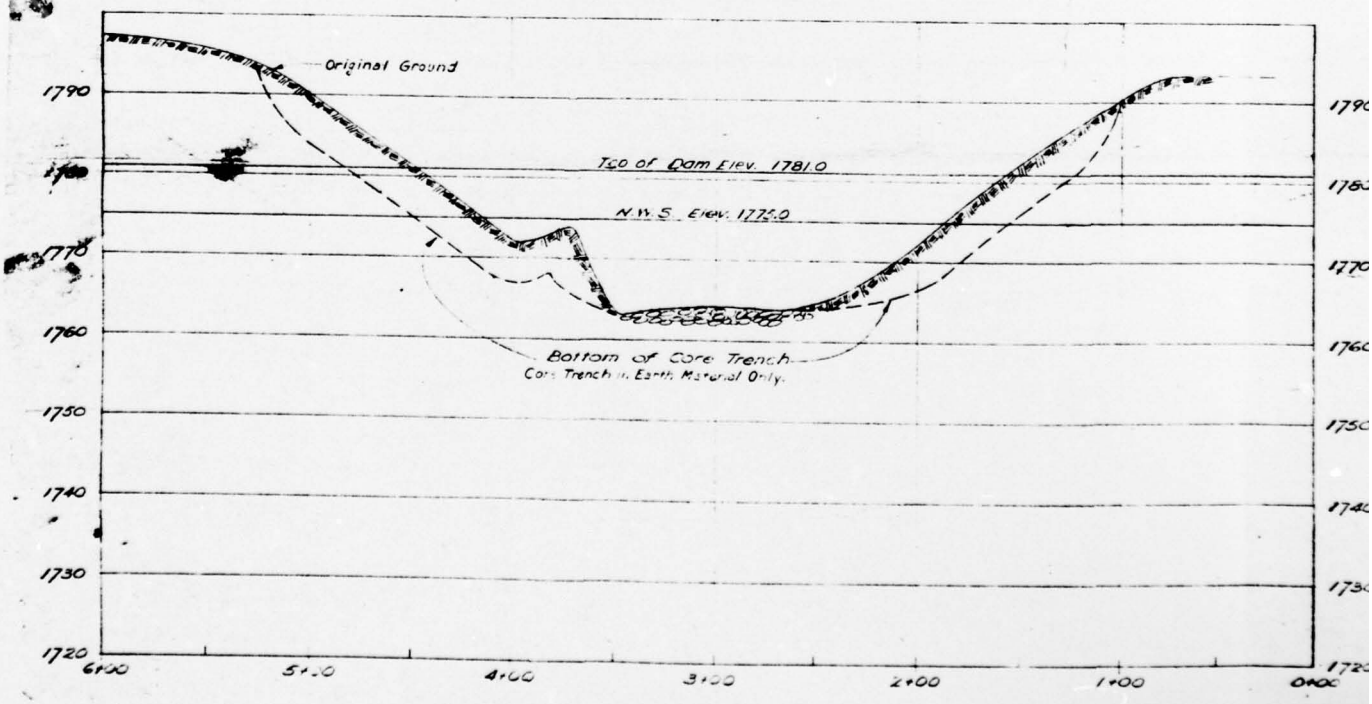
NAT.I.D.NO.PA.00615 — CARBON COUNTY

DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO.551-2, DATED 3/1/57

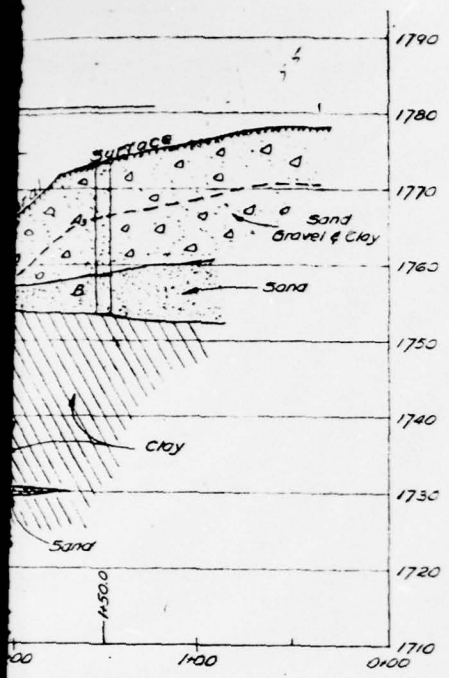
PLATE 2

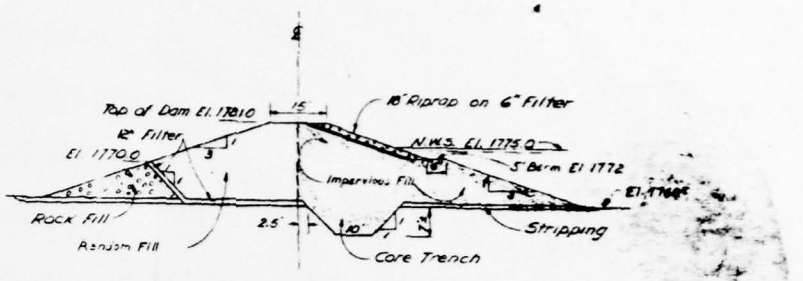


DAM "A" - ℄ PROFILE

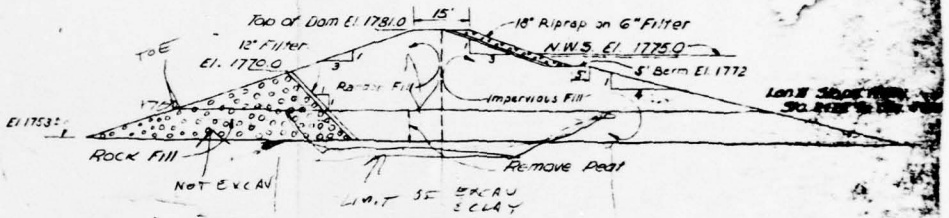


DAM "B" - ℄ PROFILE

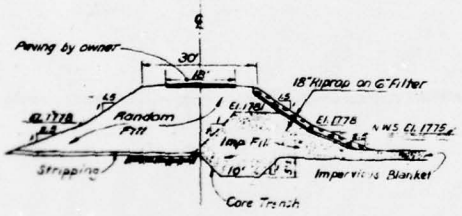




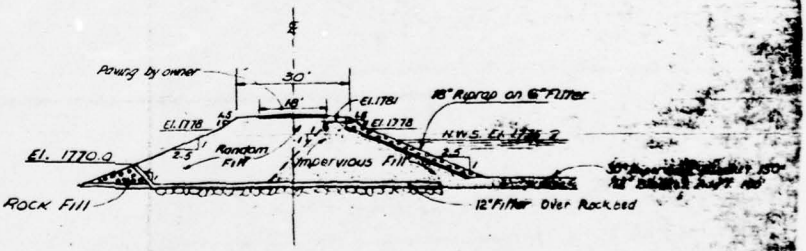
DAM "A"
SECTION "A-A"



DAM "A"
SECTION "B-B"



DAM "B"
SECTION "D-D"



DAM "B"
SECTION "C-C"

— LEGEND —

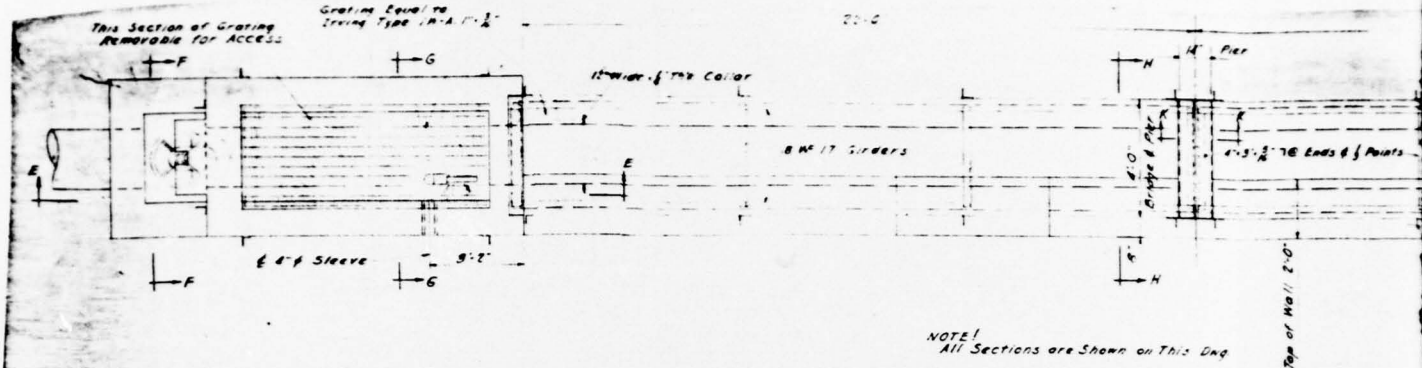
A	SAND, CLAY & GRAVEL COMBINATIONS.
B	ROCK - WITH SMALL BOULDERS.
C	ROCK - WITH BOULDERS.
D	SAND
E	SILT COMBINATIONS
F	SILT MIXTURES
G	CLAY COMBINATIONS.
H	BOULDERS
I	SANDSTONE
J	SHALE
K	CRYSTALLINE ROCK.

PROFILE AND EMBANKMENT SECTIONS
BIG BOULDER DAM

NAT.I.D.NO.PA. 00615 | CARBON COUNTY

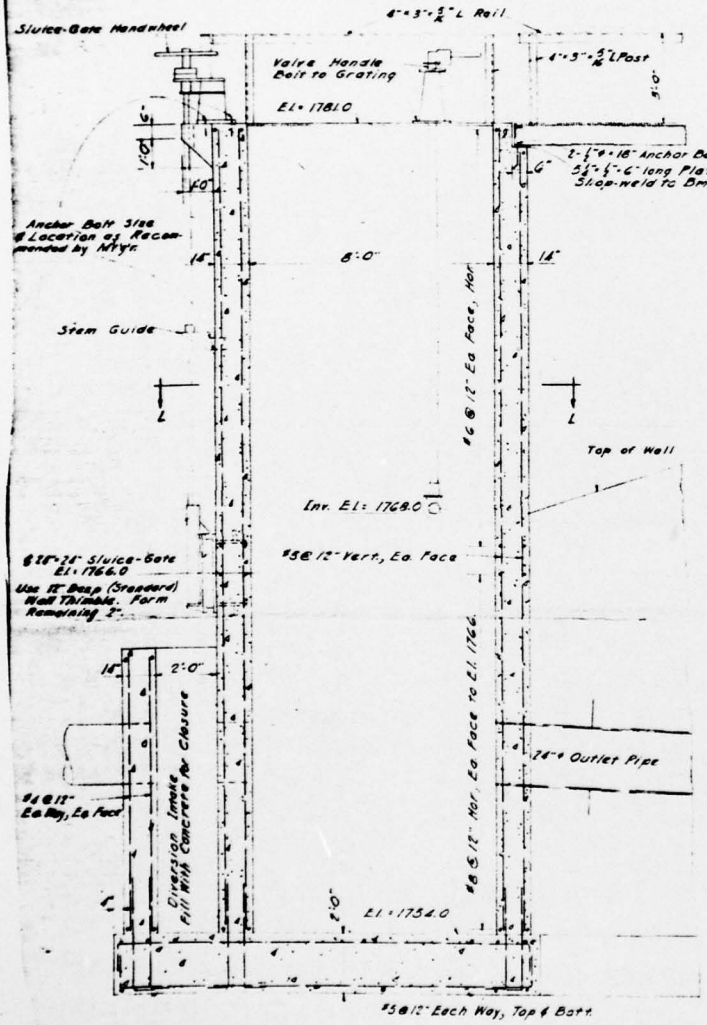
DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO. 551-5, DATED 3/1/57

PLATE 3



NOTE! All Sections are Shown on This Dwg.

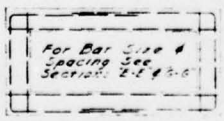
PLAN OF INTAKE & BRIDGES



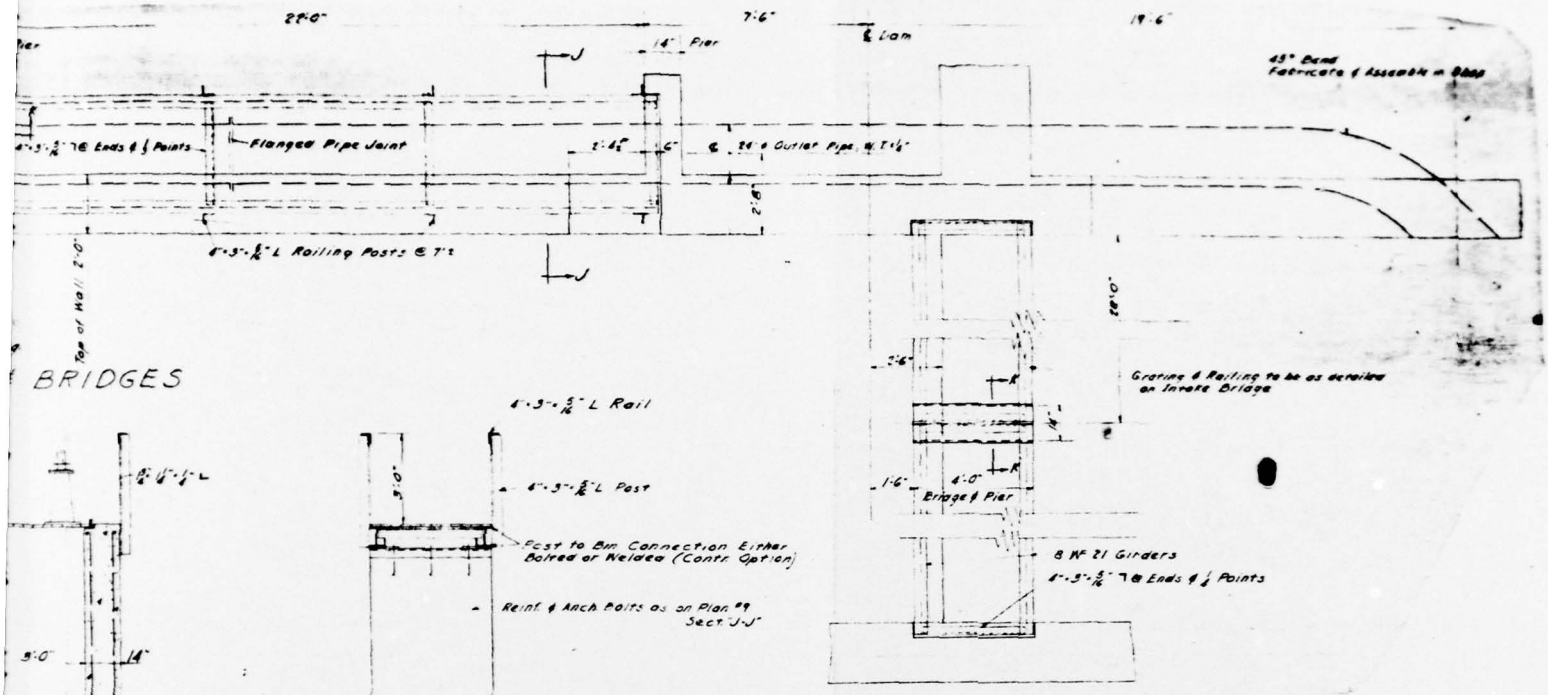
SECTION "E-E"

SECTION "F-F"

SECTION "G-G"



SECTION "L-L"



BRIDGES

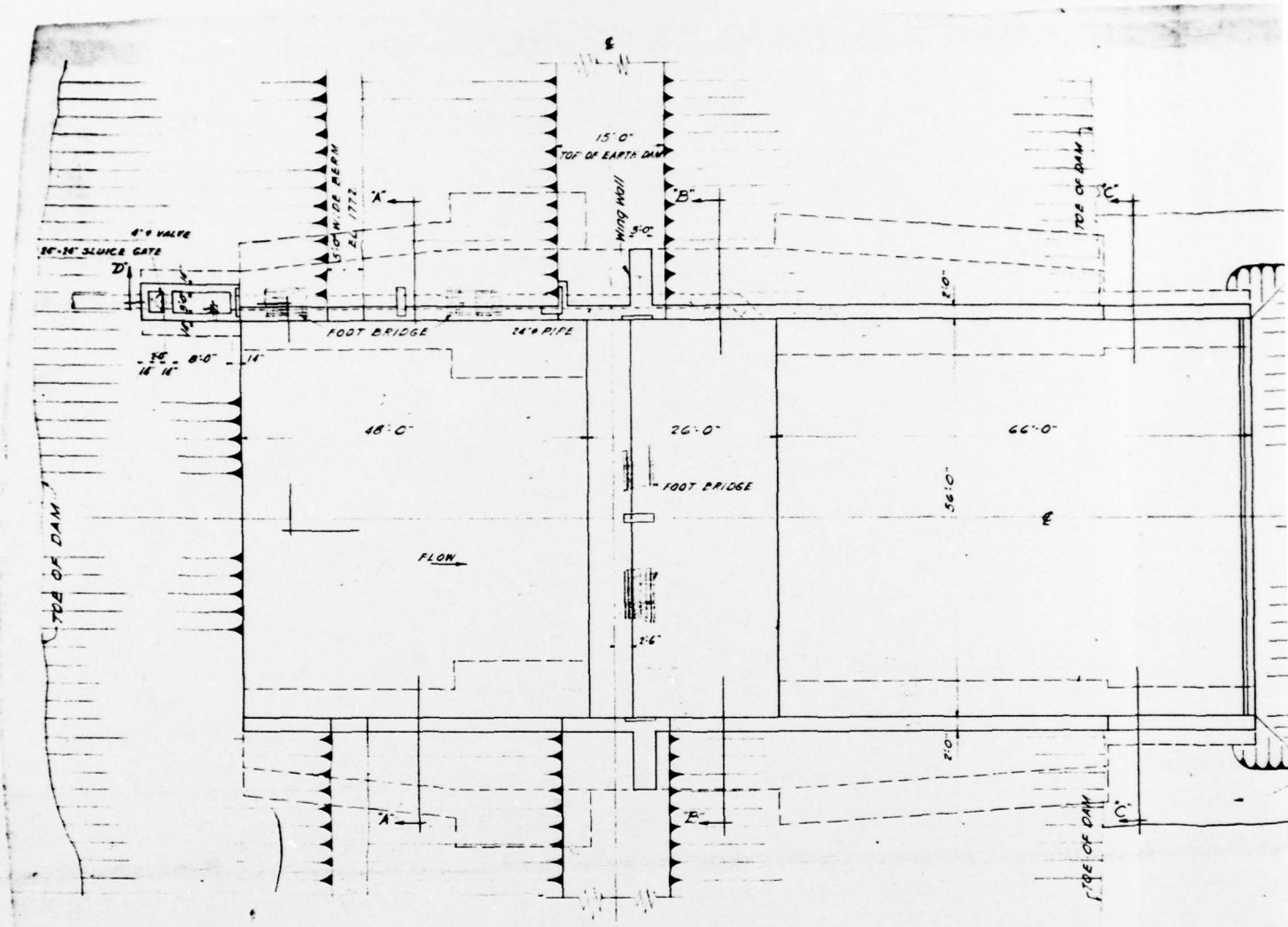
INTAKE TOWER AND BRIDGE
BIG BOULDER DAM

NAT.I.D.NO.PA.00615 **CARBON COUNTY**

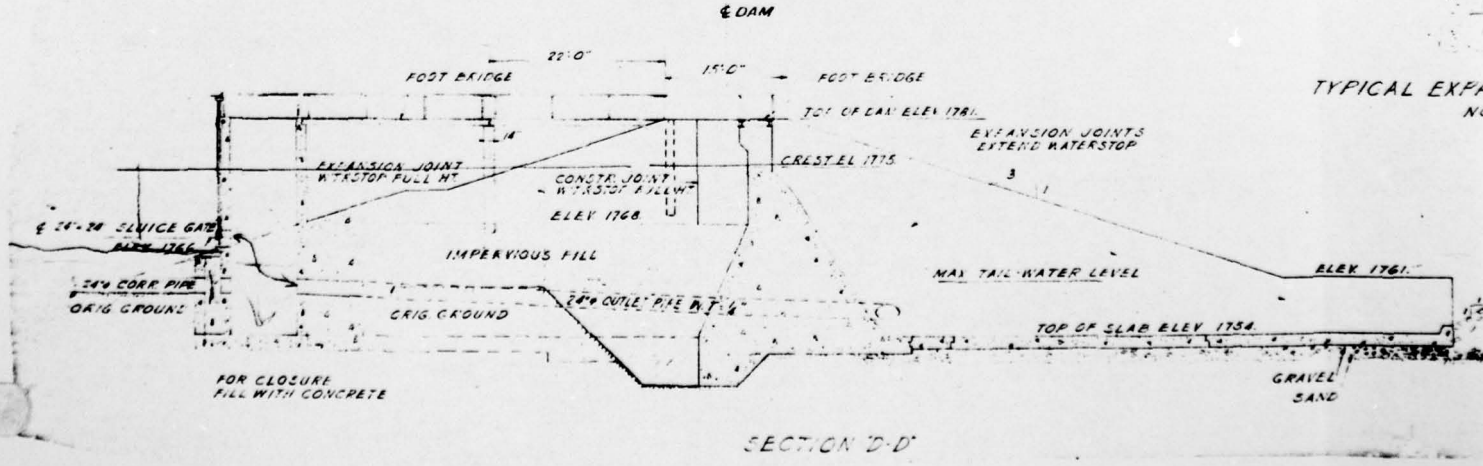
DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO.551-10, DATED 3/1/57

PLATE 4

2

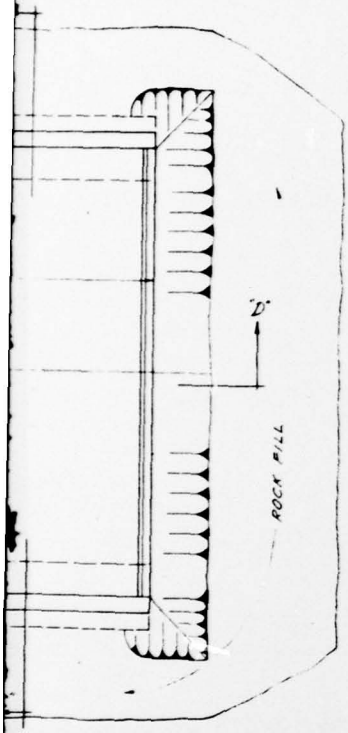


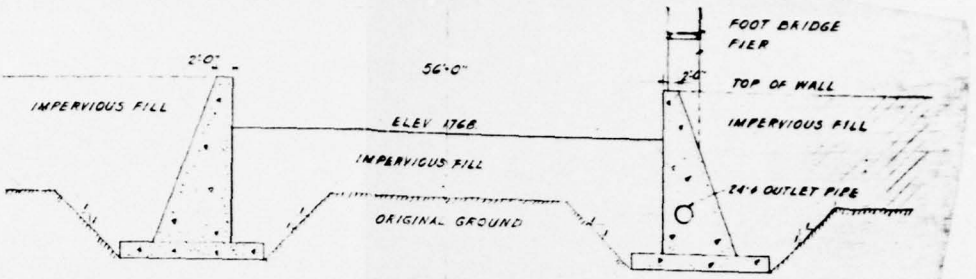
PLAN VIEW OF SPILLWAY



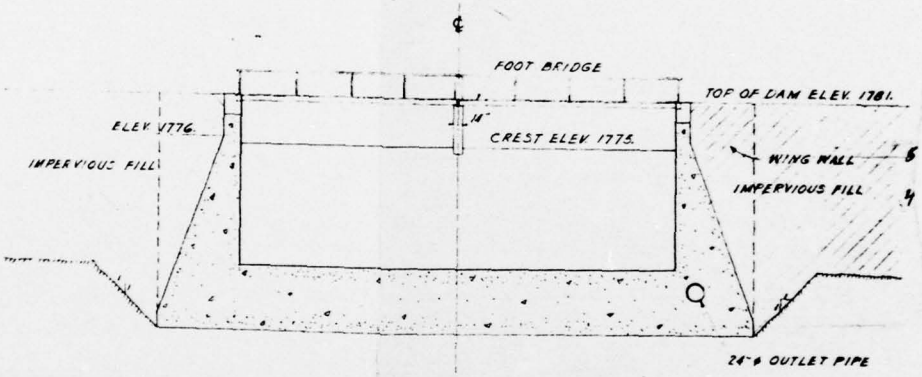
SECTION 'D-D'

TYPICAL EXPA

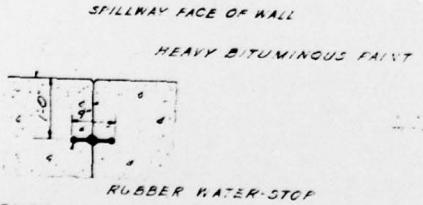




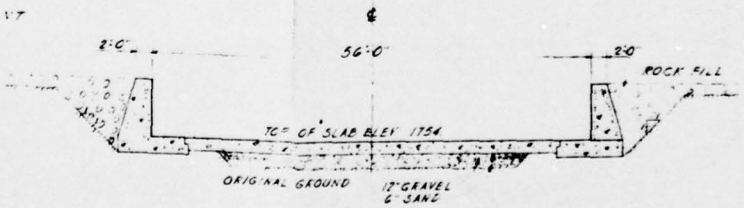
SECTION A-A"



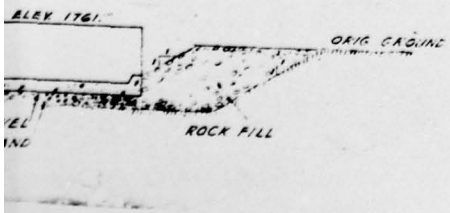
SECTION "B-B"



TYPICAL EXPANSION JOINT DETAIL
NO SCALE



SECTION "C-C"



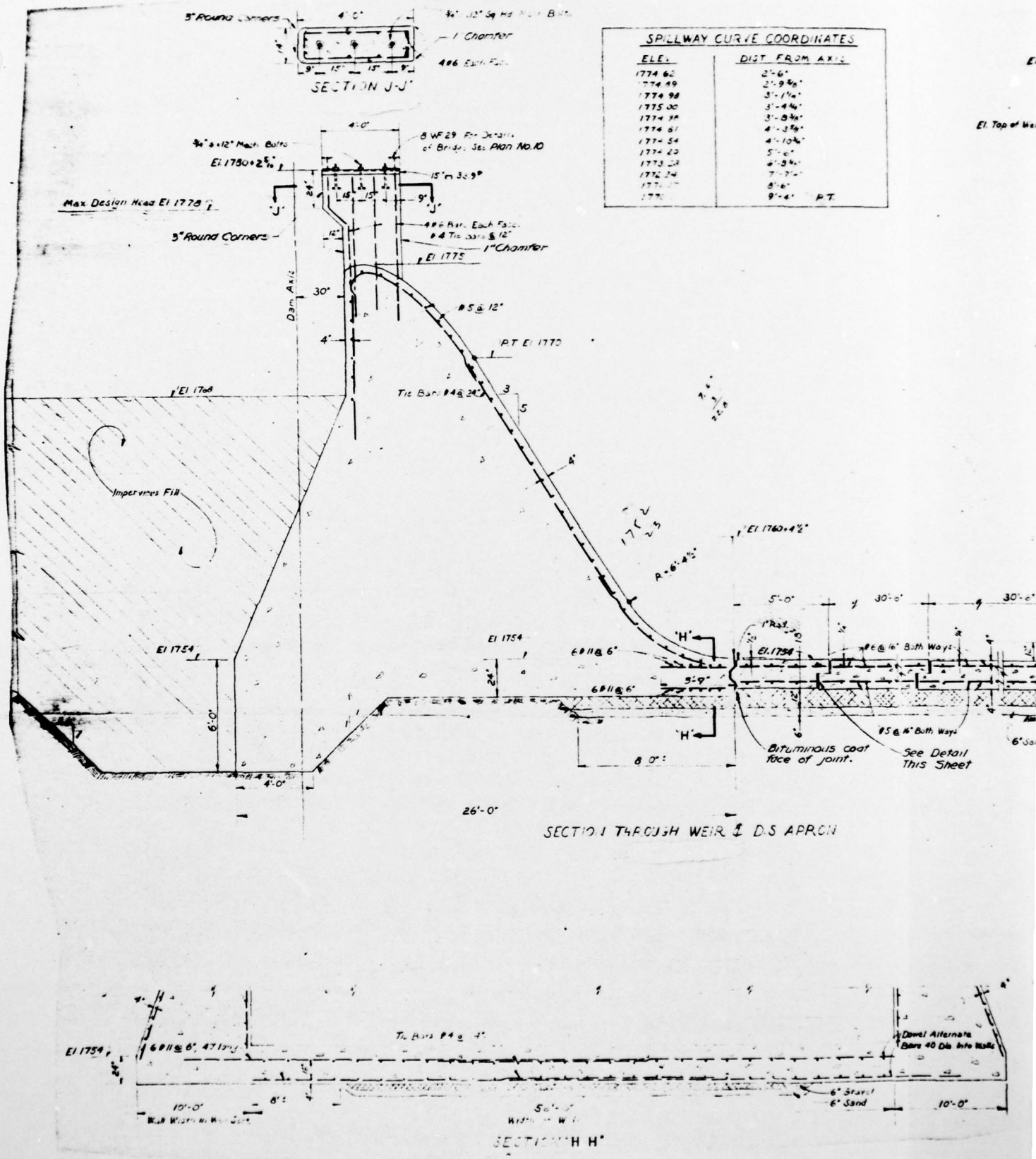
2

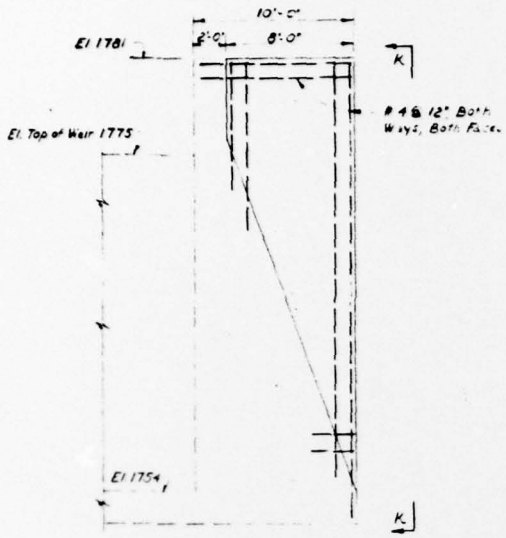
SPILLWAY— PLAN, PROFILE AND SECTIONS
BIG BOULDER DAM

NAT.I.D.NO.PA.00615 **CARBON COUNTY**

DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO. 551-6, DATED 3/1/57

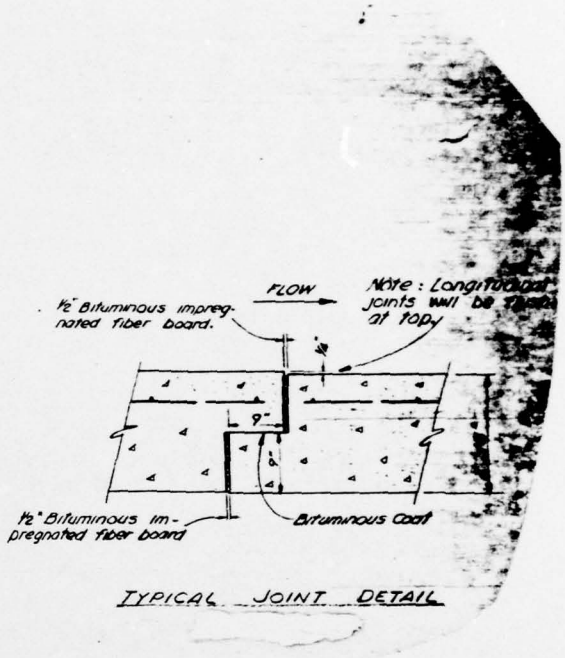
PLATE 5


SECTION J-J'
3" Round Corners
1" Chamfer
4'-0"
9"
15"
15"
9"
SPILLWAY CURVE COORDINATES
ELE.
DIST FROM AXIS
1774.62
1774.49
1774.98
1775.00
1774.98
1774.61
1774.54
1774.23
1773.28
1772.24
9'-4" P.T.
Max Design Head El 1778
El 1780+2 5/16"
8 WF 29 For Details of Bridge See Plan No. 10
15"
24"
12"
#4 Ties @ 12"
1" Chamfer
El 1775
Dam Axis
30"
#5 @ 12"
4"
P.T. El 1770
El 1768
Tie Bars #4 @ 24"
Impervious Fill
El 1760+4 1/2"
R = 6'-4 1/2"
5'-0"
30'-0"
El 1754
#11 @ 6"
#5 @ 16" Both Ways
Bituminous coat face of joint.
See Detail This Sheet
6'-0"
4'-0"
8'-0"
26'-0"
SECTION THROUGH WEIR & D.S APRON
Tie Bars #4 @ 4'
Dowel Alternate Bars 40 Dia into Walls
6" Gravel
6" Sand
10'-0"
SECTION H H'

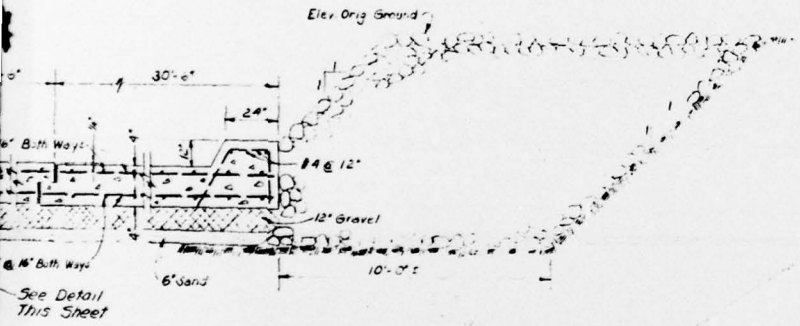


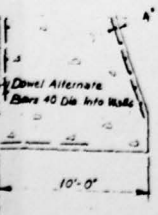
WING WALL

SECTION K-K



TYPICAL JOINT DETAIL



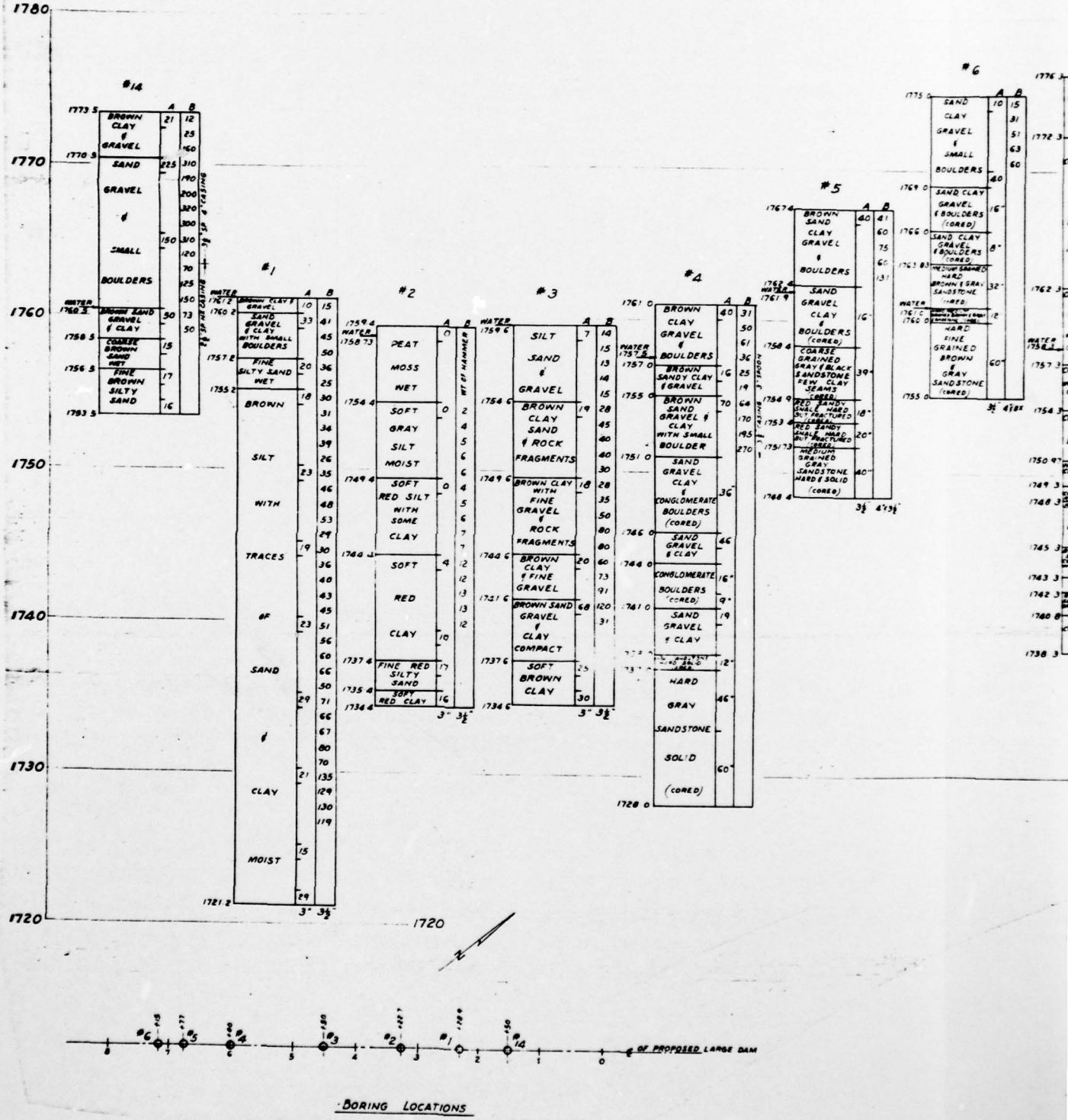


SPILLWAY WEIR DETAILS
BIG BOULDER DAM

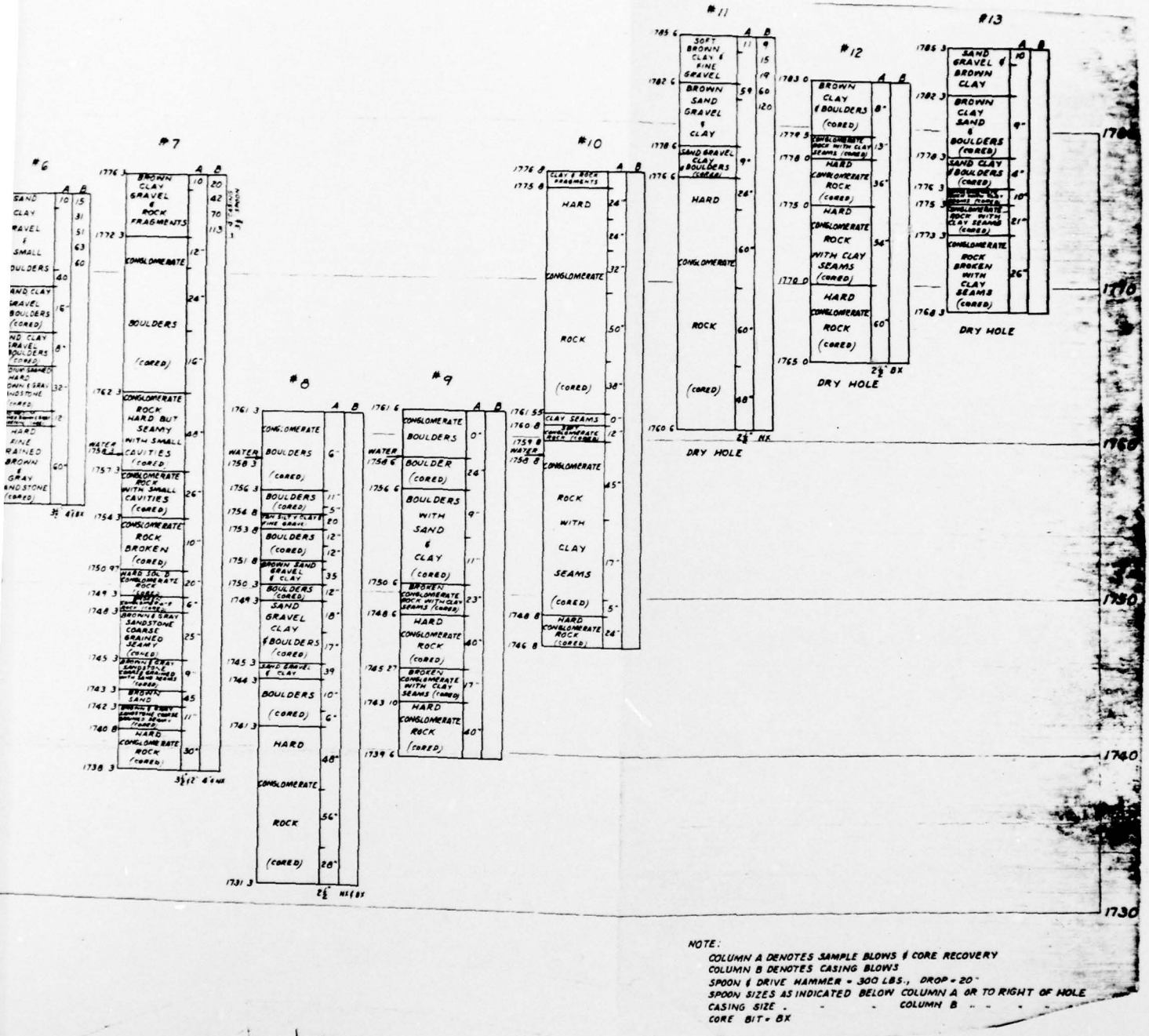
NAT.I.D.NO.PA.00615 **CARBON COUNTY**

DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO. 551-9, DATED 3/1/57

PLATE 6

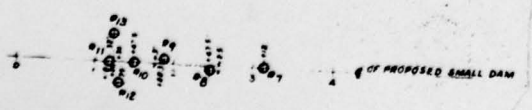


BORING LOCATIONS



NOTE:
COLUMN A DENOTES SAMPLE BLOWS & CORE RECOVERY
COLUMN B DENOTES CASING BLOWS
SPOON & DRIVE HAMMER = 300 LBS., DROP = 20"
SPOON SIZES AS INDICATED BELOW COLUMN A OR TO RIGHT OF HOLE
CASING SIZE . . . COLUMN B . . . .
CORE BIT = BX

NOTE
THIS DRAWING WAS MADE BY SPRAGUE & HENWOOD INC. AND DATED 1-4-56.



BORING LOCATIONS

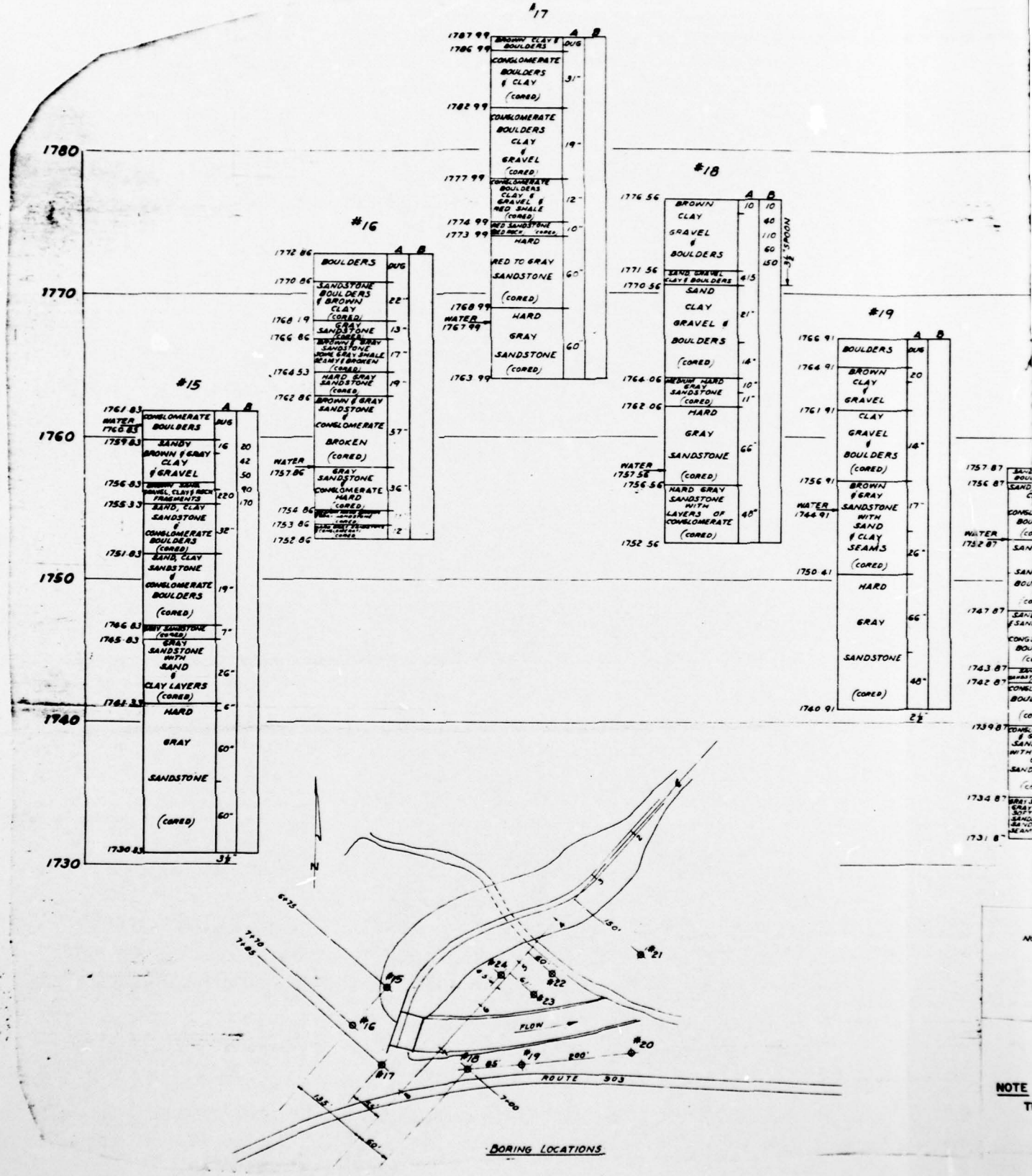
LOGS OF TEST BORINGS (SHEET 1 OF 2)

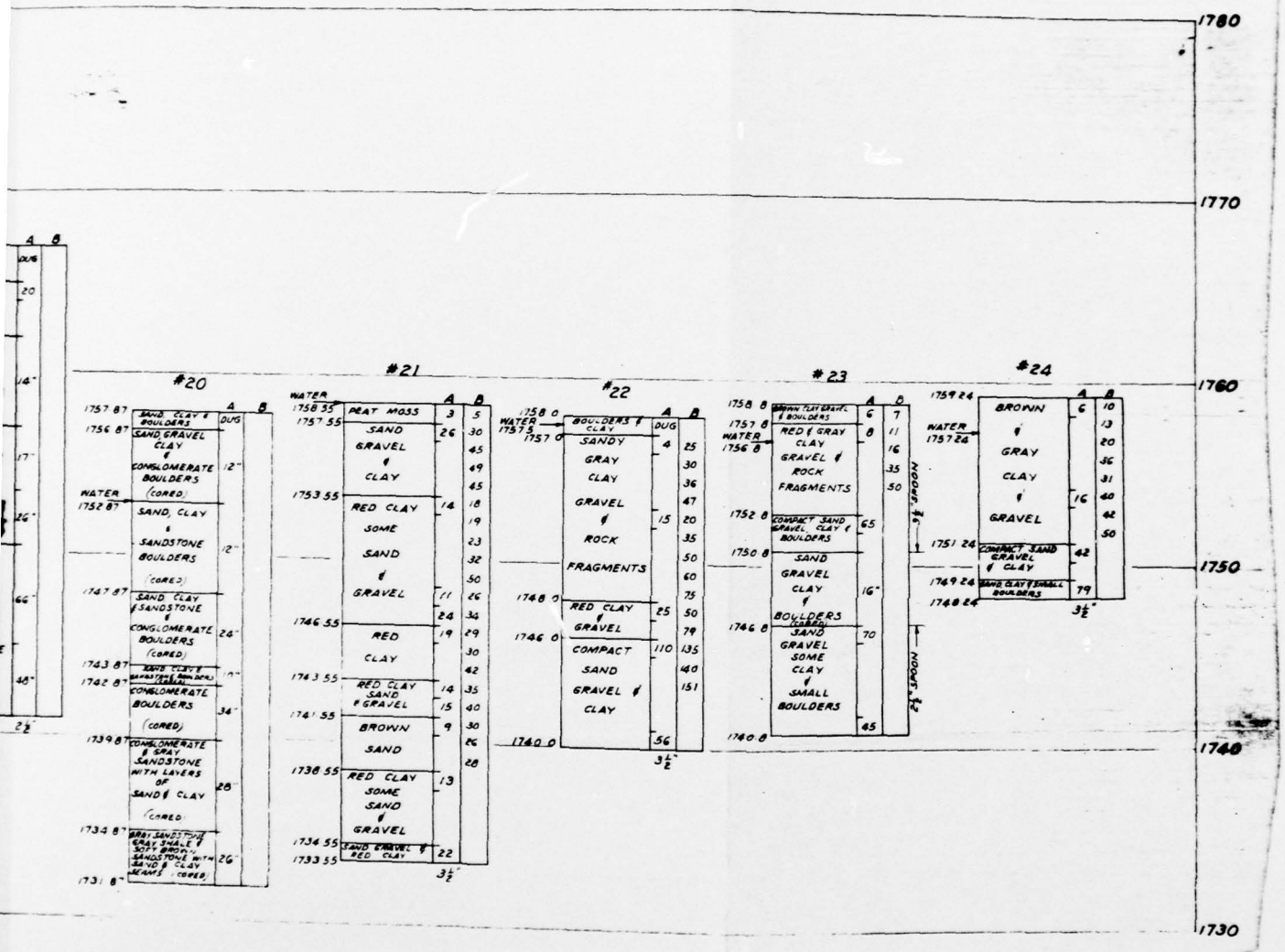
BIG BOULDER DAM

NAT.I.D.NO.PA.00615 — CARBON COUNTY

DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO. 551-3, DATED 3/1/57

PLATE 7


#15
#16
#17
#18
#19
1780
1770
1760
1750
1740
1730
BORING LOCATIONS
ROUTE 903
FLOW
NOTE



NOTE

COLUMN A DENOTES SAMPLE BLOWS & CORE RECOVERY
COLUMN B DENOTES CASING BLOWS
SPOON & DRIVE HAMMER = 300 LBS., DROP = 20"
SPOON SIZE AS INDICATED BELOW COLUMN A OR TO RIGHT OF HOLE
CASING SIZE = 4" CORE BIT = BX

NOTE

THIS DRAWING WAS MADE BY SPRAGUE & HENWOOD INC. AND DATED 8-18-56.

2

LOGS OF TEST BORINGS (SHEET 2 OF 2)

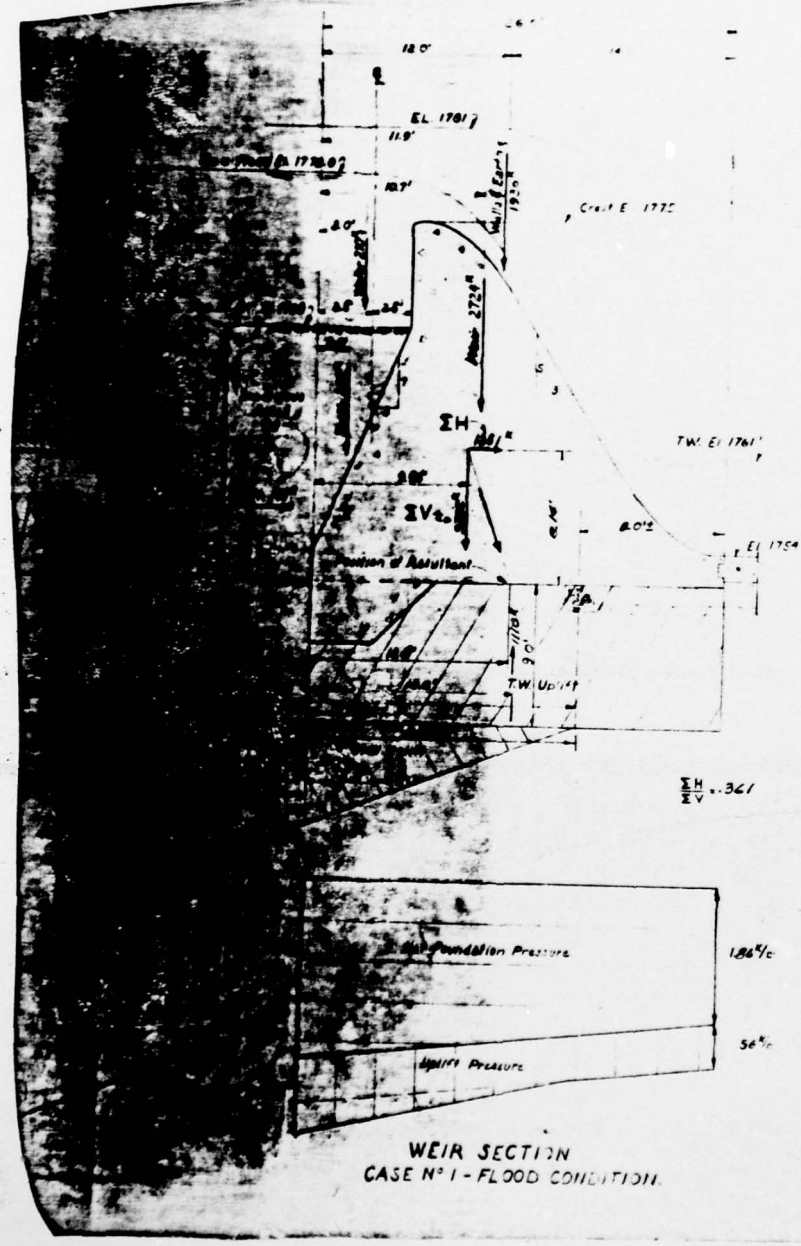
BIG BOULDER DAM

NAT.I.D.NO.PA.00615

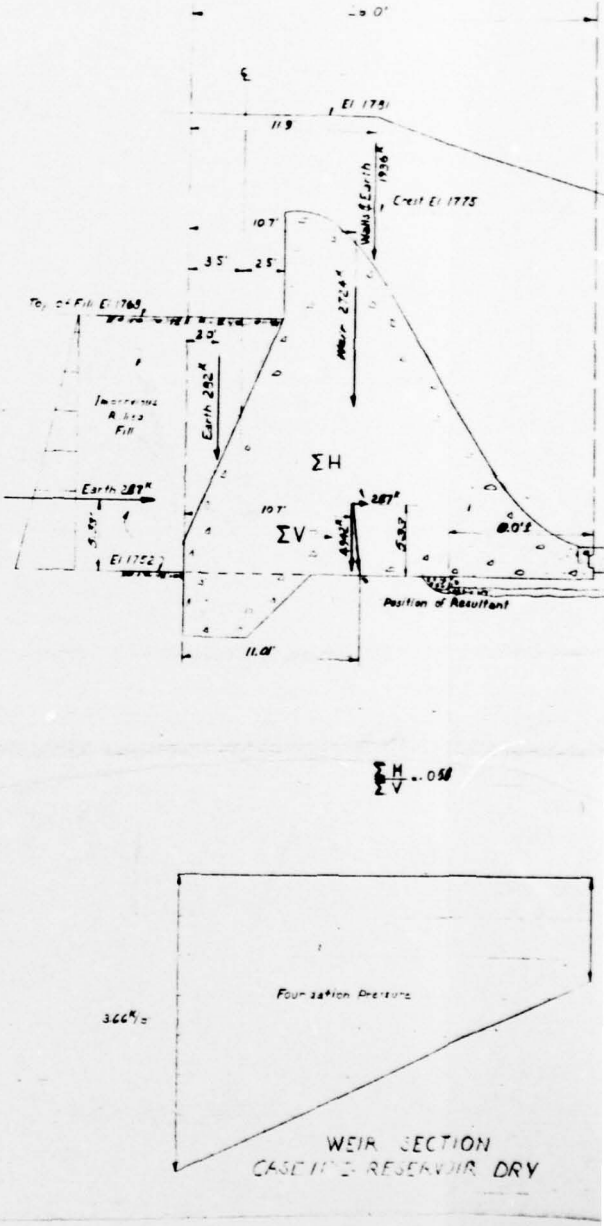
CARBON COUNTY

DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO.551-4, DATED 3/1/57

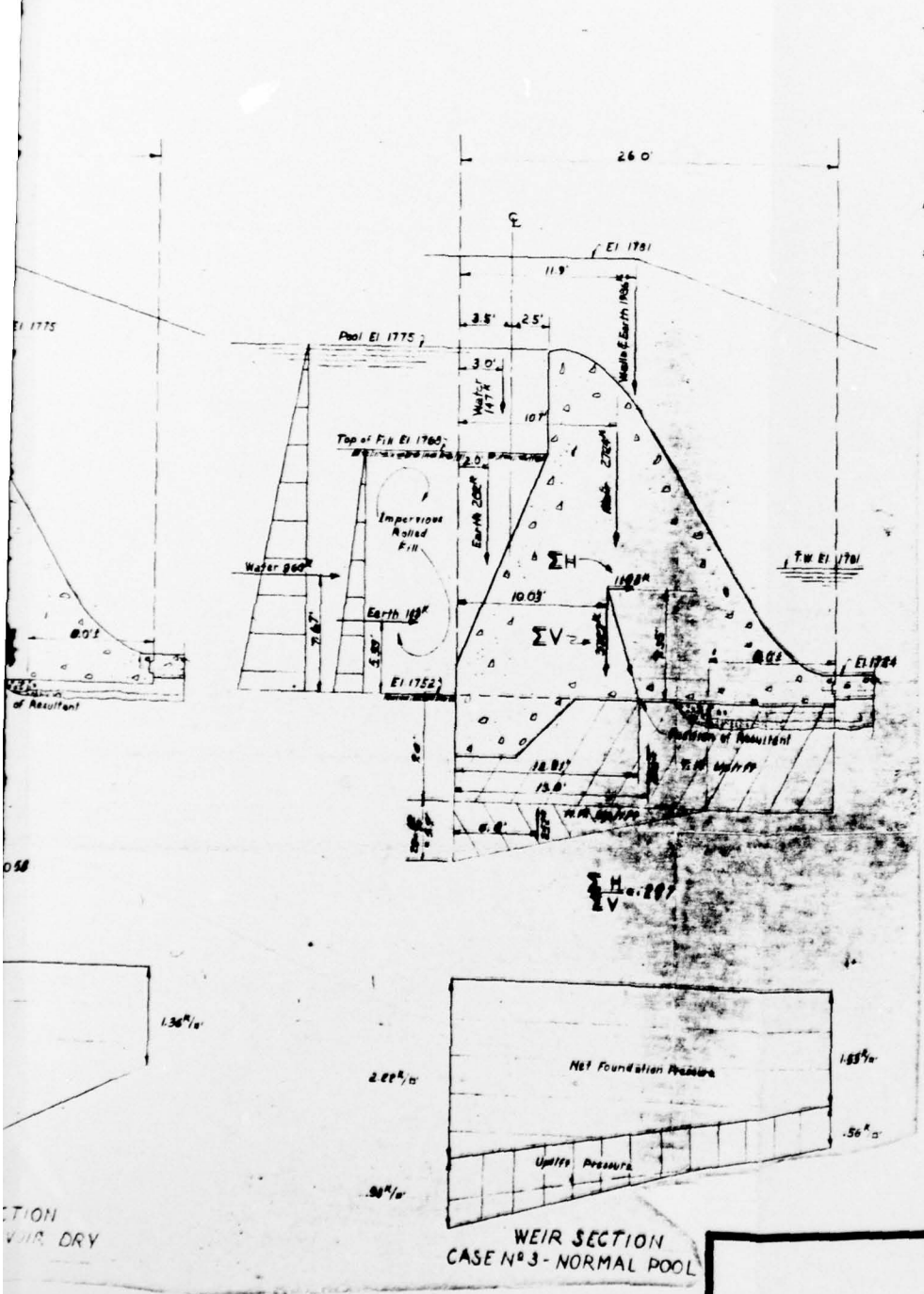
PLATE 8



WEIR SECTION
CASE N° 1 - FLOOD CONDITION.



WEIR SECTION
CASE II - RESERVOIR DRY



Assumptions

Tail Water [illegible] Acting Over Entire Base Area, Head Water [illegible] Face of Dam

[illegible] 70 Distance Measured to Full Head [illegible] Gravel Bed

[illegible] Water 62.4 #/Cu Ft, Earth 120# C.M.

Equivalent [illegible] Pressure Submerged Earth 20[illegible] Lbs. Ft., Dry Earth 42 #/Sq. Ft.

Gravity Section Considered as Unit, Including Weir Walls for 26' Section by 76' Width.

Uplift Considered Over 76' Width.

Upstream Water Pressure Considered for 58' Width.

Notations:

$\frac{\Sigma H}{\Sigma V}$ = Sliding Factor

ΣH: Summation of Horizontal Forces

ΣV: Summation of Vertical Forces

STABILITY ANALYSIS

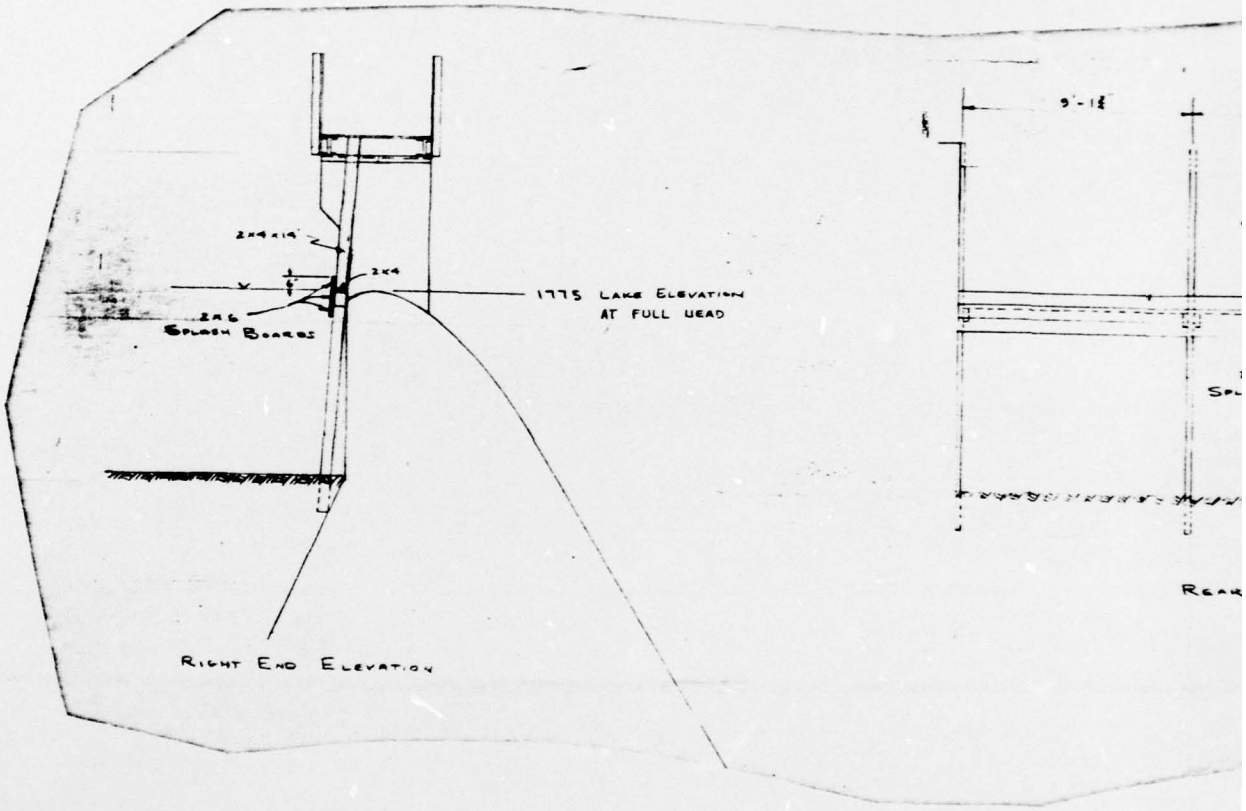
BIG BOULDER DAM

NAT.I.D.NO.PA.00615 CARBON COUNTY

DATA OBTAINED FROM JUSTIN AND COURTNEY, CONSULTING ENGINEERS, PHILA., PA., PLAN NO. 551-SA, DATED 3/1/57

PLATE 9

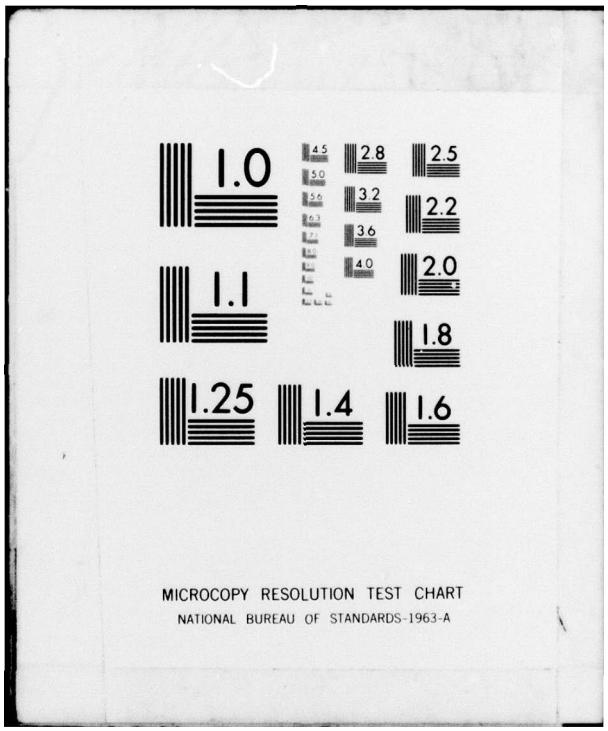
2

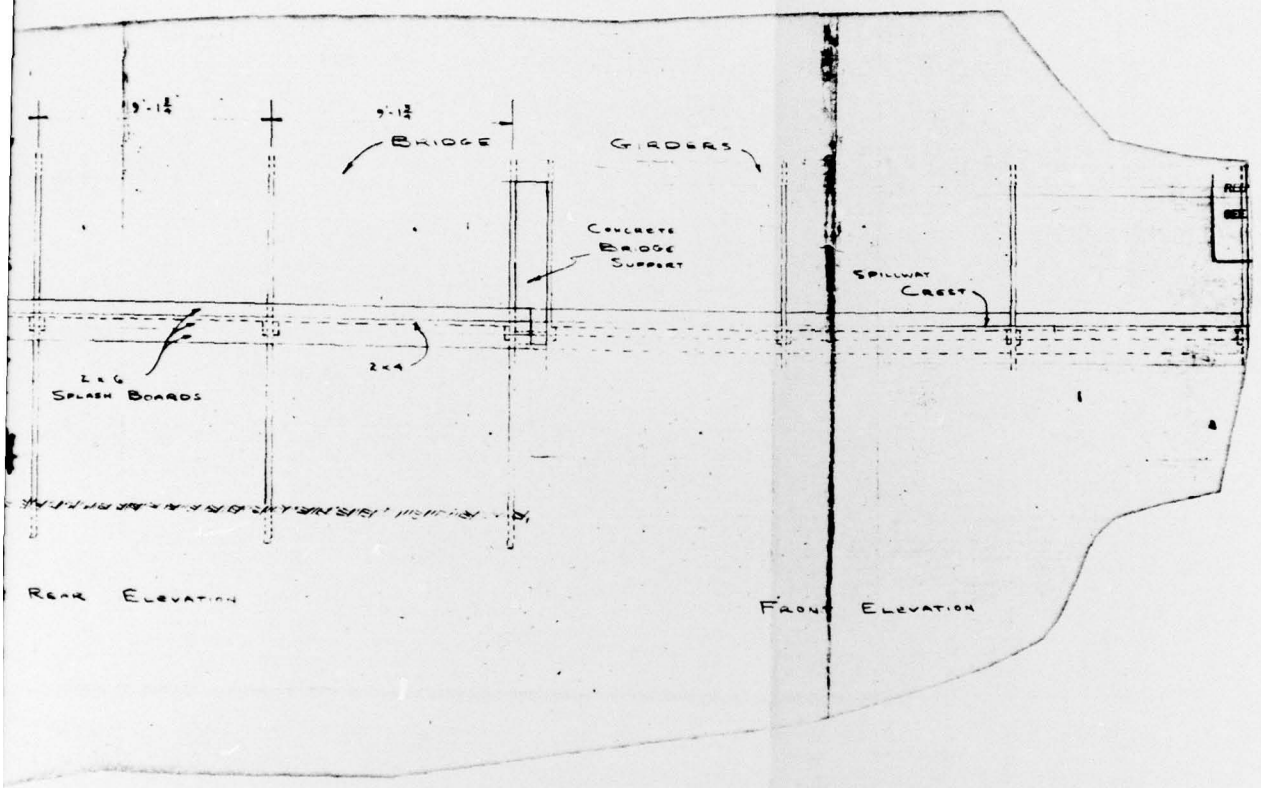

2x4 x 12'
2x4
2x6
SPLASH BOARDS
1775 LAKE ELEVATION
AT FULL HEAD
RIGHT END ELEVATION
9'-1E
REAR

AD-A078 878 WOODWARD-CLYDE CONSULTANTS PLYMOUTH MEETING PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. BIG BOULDER DAM (NDS ID NUMBER--ETC(U)
JUL 79 J BOSCHUK DACW31-79-C-0017
UNCLASSIFIED NL

2 OF 2
AD
A078878

END
DATE
FILMED
1-80
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



SPLASH BOARD INSTALLATION DETAILS
BIG BOULDER DAM

NAT.I.D.NO.PA.00615 — CARBON COUNTY

DATA OBTAINED FROM SPLIT ROCK LODGE INC., KIDDER TWP.,CARBON COUNTY,PA.,SKETCH DATED 4/4/63

PLATE 10

2

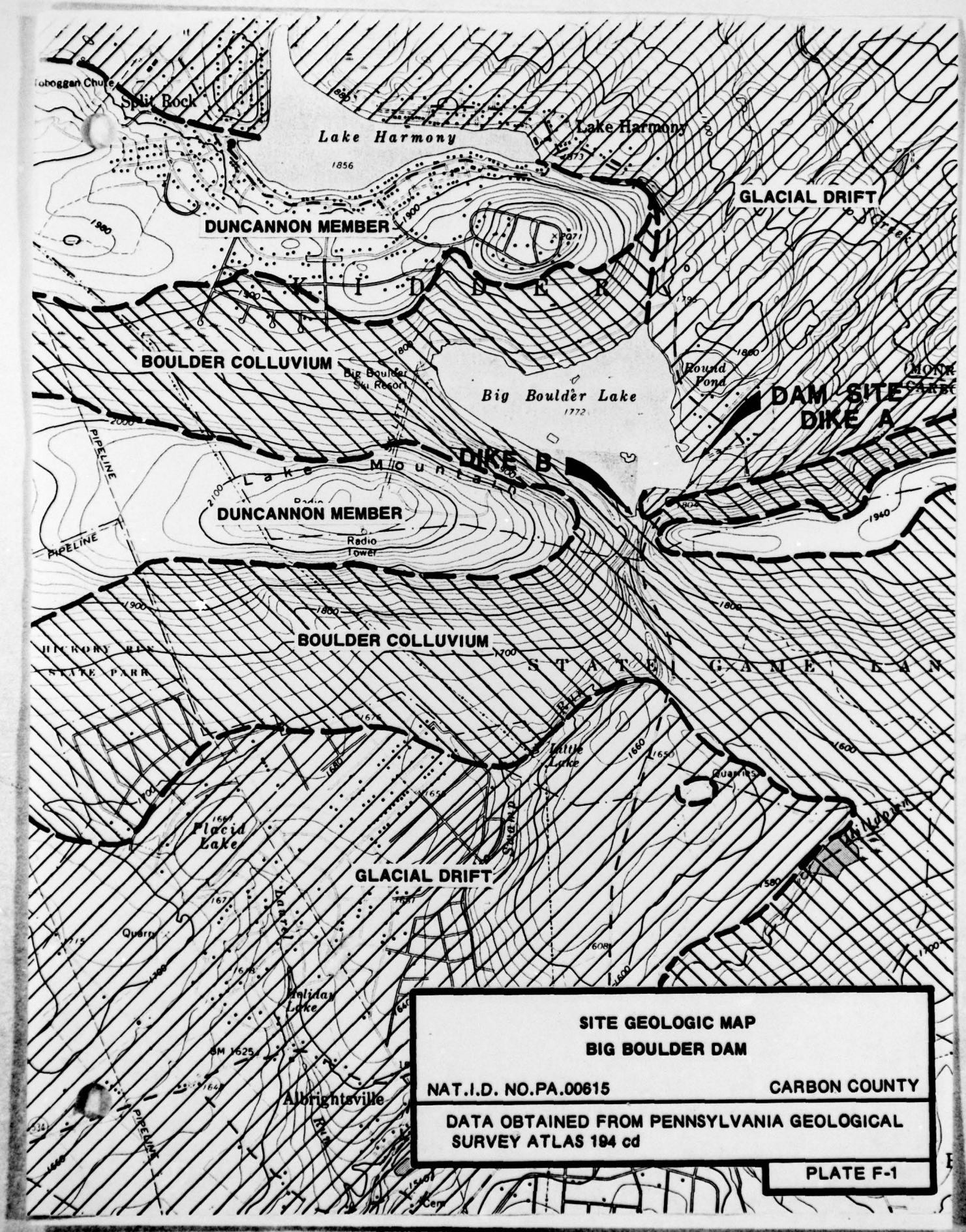
APPENDIX

F

SITE GEOLOGY
BIG BOULDER

Big Boulder Dam is located in the Pocono Plateau Section of the Appalachian Plateaus Physiographic Province. As shown on Plate F-1, the dam and surrounding region, as is much of northeastern Pennsylvania, are underlain by the Upper Devonian age Duncannon Member of the Catskill Formation. Surficial deposits in the area consist of a partial mantle of Wisconsin age glacial drift and boulder colluvium. No bedrock exposures were encountered during the field inspection. However, the character of the Duncannon Member in this region is typically a grayish-red sandstone having interbeds of shale, siltstone and conglomerate. Rock bedding would be expected to have an overall northeasterly strike. A series of northeast-southwest trending folds occur in the dam region resulting in rather changeable direction and angle of bedding dip.

Information available in a preliminary report dated September 26, 1956, of Justin & Courtney describes the preconstruction subsurface of Dam A to consist of sandy gravels with clay mixtures and areas of peat. The core trench in the right abutment ties into bedrock. Dam B is founded upon naturally impervious soils located adjacent to a boulder field.



SITE GEOLOGIC MAP
BIG BOULDER DAM

NAT.I.D. NO.PA.00615 **CARBON COUNTY**

DATA OBTAINED FROM PENNSYLVANIA GEOLOGICAL SURVEY ATLAS 194 cd

PLATE F-1